Sci

LOS ANGELES PUBLIC LIBRARY

JAN 4 - 1961

For a Better Tomorrow
(See caption, p. 3)

STACKS

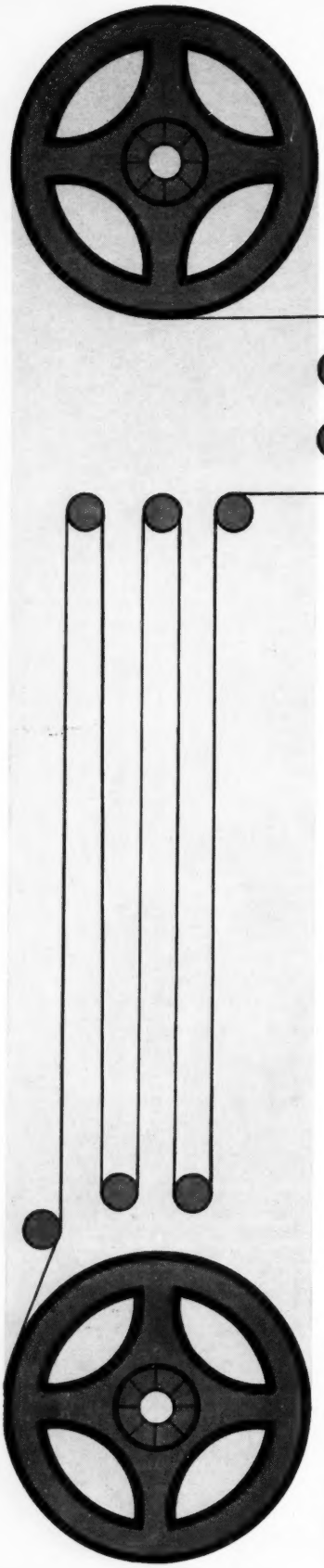
December, 1960

MR

METALS REVIEW

The News Digest Magazine

LOS ANGELES PUB LIB
ATT HELEN E LAUGHLIN
630 W. FIFTH ST
LOS ANGELES 17 CAL 513840



SOLVE YOUR LITERATURE

SEARCHING PROBLEMS—EASILY,

INEXPENSIVELY, COMPLETELY—

ASM'S NEW INFORMATION SEARCHING SERVICE

Say good-bye to page-by-page searching of hundreds of magazines for technical information . . . because the American Society for Metals is coding, on electronic tape, every current metals article from over 600 of the world's leading magazines . . . plus patents, government reports, books, everything published.

You can subscribe to the use of this tape through Information Searching of ASM's Documentation Service. As a subscriber, you tell ASM the subject in which you are interested. Then, every two weeks ASM sends you digests of only the current published information which touched on that interest. Your requested subject can be as broad as "vacuum melting and pouring" or as definitive as "properties of stainless steel for temperatures down to —423° F." Whatever your interest, ASM sets its electronic searching selector and from the tape comes your tailor-made digests. From these digests you may then order photocopies of the articles you want for your library or for immediate reference.

ASM's Information Searching is a major breakthrough for any firm which looks to technology for the solution to metals problems. It can inexpensively provide what until now was impossible; a complete and continuing world library of specific information without the turning of a page. A descriptive booklet will answer any questions you may have—how Information Searching can save you and your firm the time and money now spent for page-by-page literature searching—how it can keep you completely current. For your copy, mail this coupon to: American Society for Metals • Documentation Service • Metals Park • Novelty, Ohio.

Name_____

Title_____

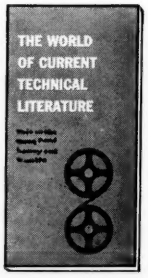
Company_____

Street_____

City_____ Zone____ State_____

AMERICAN SOCIETY FOR METALS

Documentation Service • Metals Park • Novelty, Ohio



December, 1960 Vol. XXXIII, No. 12

METALS REVIEW

The News Digest Magazine

T. C. DuMond
Editor

Betty A. Bryan
Associate Editor

James C. Nelson
Associate Editor

A. P. Ford
Sales Manager

William J. Hilty
Advertising Manager

G. H. Loughner
Production Manager

ADVERTISING OFFICES

Rodney W. Cramer
Metals Park, Novelty, Ohio
JOrdan 4-2271

John B. Verrier, Jr.
Fred Stanley
David Brooks
342 Madison Ave., Room 1228
New York 17, N.Y.
OXford 7-2667

David A. Lewis
P.O. Box 9740
Pittsburgh 29, Pa.
WEllington 1-2123

William Graham
53 W. Jackson Blvd.
Chicago 4, Ill.
WAbash 2-7822

Donald J. Walter
20050 Livernois St.
Detroit 21, Mich.
UNiversity 4-3861

William F. Mills
(Whaley-Simpson Co.)
6608 Selma Ave.
Los Angeles 28, Calif.
HOllywood 3-7157

Gordon Simpson
(Whaley-Simpson Co.)
700 Montgomery St.
San Francisco 11, Calif.
SUtter 1-4583

Contents

ASM's Role Seen as Essential Link Between Science and Industry, by Clyde Williams 4

Important Lectures

Value Analysis Strives to Lower Costs Without Impairing Product Quality, by Jack Kennedy 7
Role of the Metallurgical Engineer in Research, by O. T. Barnett 14
Steel's Competitive Materials, by K. B. Valentine 15
Definition of Nuclear Metallurgy, by B. Lustman 16
Development of Space Age Alloys, by A. P. Terrile 17
Oxygen in Steelmaking, by A. L. Hodges 17
Need for Constant Design, Materials Changes, by E. N. Case 18
Electron Metallography, by W. L. Grube 19
Materials Costs Defer Auto Jet, by R. F. Thomson 19
Art of Metallurgy Still Leads the Science, by B. Chalmers 21

Metallurgical News and Developments

Metals 8
Nonmetallics 10
Industrial Heating 11
Finishing and Coating 12
Forming and Shaping 13
Parts and Forms 13

Departments

Chapter Briefs 17
Chapter Calendar 20
Employment Service Bureau 22

COVER PHOTO

Managing Director ASM, Allan Ray Putnam (Right) and Mrs. Putnam Visit Clair C. Lasher, General Manager of General Electric Co.'s Computer Department in Phoenix, Arizona, for a Look at the Electronic Computer System Being Built for the Society's Metals Documentation Service.

Published monthly at 404 N. Wesley Ave., Mount Morris, Ill., by the American Society for Metals. Editorial and general offices Metals Park, Novelty Ohio: W. A. Pennington, President; C. E. Swartz, Vice-president; R. J. Raudebaugh, Treasurer; Merrill Scheil, Secretary; C. H. Samans, A. R. Fairchild, Morris Cohen and John Convey, Trustees; Walter Crafts, Past President. Subscriptions, $3.00 per year ($7.50 foreign). Single copies $1.50. Second class postage paid at Mount Morris, Ill. and at additional mailing offices.

Claims for missing numbers will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers from overseas, or because of failure to notify the circulation department of a change of address or because copy is "missing from files".

ASM's ROLE SEEN AS ESSENTIAL LINK BETWEEN SCIENCE AND INDUSTRY

The highest contribution of any technical organization, I believe, is the role in bridging the gap between theoretical science and the application of that science in industry. Science is useless unless put to work. And industry, as generations of experience have shown, is ponderously slow in its evolution unless it has access to the fruits of science. But to bring the two together, there must be a bridge—a connecting link.

This is where the technical society has found its opportunity for the most essential type of social service. This is where organizations such as the ASM have made their most significant contributions to the common good. This is the great opportunity and challenge for ASM.

Of course, serving as an essential link between science and industry is not the only function of the technical society, since it has other obligations, such as advancing the discipline and the professional status of its members. But even in carrying out these subsidiary objectives, the technical society is most successful when it stands as a bridge between the respective capabilities and activities of people in science and people in industry. Only those technical societies that accept and perform well in this role *earn the ability* to erect magnificent structures such as the one we dedicate today.

Just how has the American Society for Metals served as an essential link between science and industry?

It has provided the seminars and platforms from which scientists and technologists can express their ideas and announce their research findings, as other technical societies have done. It also has provided the publication media for the wider dissemination of such ideas and for their interpretation to men of action in industry. In addition, the ASM, through many overt acts and devices, some original to it, has brought metallurgical scientists and industry closer together, so that scientists can better understand industry and industry can better understand what scientists can offer. The ASM metals show is an outstanding example, as are the regional and sectional programs, where executives of industry rub shoulders with academic and theoretical metallurgists.

The fact that 40% of ASM membership is made up of executives and production personnel is highly significant. It speaks clearly for the maintenance of the intent of the founder members, namely that the Society should be a forum where metals scientists and practical operating people could forgather and exchange with each other their knowledge and personal experiences. Possibly because of ASM influence, metals science is regarded as one of the most practical and down-to-earth of scientific disciplines. Certainly, ASM has helped industrial executives understand the technologist, and because the executive does understand and appreciate him, the technologist has received support for his work and progress has been more rapid.

Through the news and advertising columns of its periodical publications—through its books and handbooks—through its abstracting and informational services—through the home study courses for students and workers administered by its Metals Engineering Institute — and through its other educational and service programs—the ASM has strengthened the bond between science and industry. And always it has been ready to accept new and better ways to accomplish its goals. For instance, it was among the very first to investigate machine methods for the searching of technical literature—a subject I want to discuss more fully later.

In the character of its people, too, the ASM has been a force linking science and industry. Some have been distinguished scientists, with a feel for industry and a mission to see scientific knowledge usefully applied. Others have been industrially trained, or have been competent as professional administrators and organizers, with a deep appreciation of the value of science. All have been people of exceptional integrity and dedication.

Link of National Interest

This role that the technical society plays as a link between science and industry, I feel certain, will become of great national interest—in

---

Editor's Note: *Featured speaker at ceremonies dedicating ASM's new headquarters was Clyde Williams, president, Clyde Williams & Co., and for many years directing head of Battelle Memorial Institute. Although his remarks were primarily centered about ASM's activities, Dr. Williams had interesting thoughts about the usefulness of technical societies and publications. Metals Review is pleased to present a major portion of his talk.*

fact, great national moment—as time progresses. To accelerate technological progress and to better provide for our defense, we as a nation have been spending increasing amounts on research. But an ever-enlarging research activity can only be justified if there is assurance as is the contribution of our professional societies, technical and trade publications, and even some of our news magazines and newspapers—we do not have *adequate* communications between science and the industries. As a result, we are not getting the maximum benefits from our scientific effort.

It is estimated by the Small Business Administration that there are possibly 250,000 companies in this country that are getting little benefit from the vast amount of research information developed by the federal government, mainly because they do not know that it is available and applicable for their problems. A greater volume of research would mean even more useful information not disseminated where it could do good. Obviously, we need even a stronger ASM. And we need more organizations like it—more technical publishers—more interpreters of scientific information—to get the tremendous volume of knowledge emanating from our research laboratories to potential appliers. We must seek and find better methods for getting information interpreted and disseminated before we can expect the fullest realization from research.

The reality of this problem—and the importance of suitable links between research and industry—is pointed up by a number of developments now taking place. We are seeing more and more technical information centers come into existence such as the International Tin Council, the Defense Metals Information Center, the Plastic Technical Evaluation Center, the Cobalt Information Center, and the like. All of these are aimed at coordination and better distribution of research data. In addition there is a growing profession of technical writing and technical public relations, which seeks to interpret scientific information to nontechnical audiences such as business and industrial management.

Communications Must Keep Pace

Even in the format of our trade and technical magazines, with their short, snappy treatments of technical subjects, we see evidence of compression and interpretation of information, so that as many nuggets of useful knowledge as possible can be brought to the reader. Clearly we have come to grips with the communications problem —and clearly also we have a long way to go before we have it mastered. We have bridged the gap partially, but need more and bigger bridges. We must forge more essential links, before all of our productive ideas can be translated into productive action.

It has been suggested by some that not money, nor manpower, but inadequate communications will be the factor that may cause our total research effort to reach a point of diminishing returns. According to this reasoning, our resources for developing ideas are fast approaching the point where it will be physically impossible to get all of these ideas to potential appliers. As research expands and more and more people go into it, the proportion of idea generators increases relative to the proportion of idea appliers, with the result that an ever-enlarging stream of ideas impinges on relatively fewer and fewer people capable of putting them to work. Thus, according to this school, our research effort will reach a plateau of usefulness beyond which neither increased manpower nor money will be effective in accelerating further progress.

This line of reasoning, while mathematically valid, ignores, of course, the ability of people to face up to the communications problem and to devise ways of assimilating research information. It reminds me of the fear expressed some decades ago that research progress would be slowed because it was physically impossible for any one scientist in his lifetime to acquire all the knowledge of his discipline and thus to be in a position to add new data to that heritage of information. We licked this problem, of course, by developing specialists in science and technology and by using the team approach, thus bringing to bear on problems far more knowledge than any one man could acquire. I am certain that the communications problem will be similarly mastered—and probably through similar ingenuities.

How to Bridge the Gap

What will be the form of these ingenuities? What, more specifically, will be the new bridges over the communication gap?

I alluded earlier to two developments that I regard as highly significant. One is the emergence of specialists in information collection, interpretation and dissemination. The other is the concept of a mechanized information center that uses the latest machine techniques for the storage, organization, retrieval and dissemination of knowledge. Let's discuss these briefly.

The technical information specialist, I feel sure, will be a key figure in breaking the communications bottleneck. He will be trained in science and technology and thus capable of understanding technical subjects, but he will also have the communicative abilities of the journalist and public relations man. He will be a link between the laboratory and the executive or decision maker—or, depending on the direction of his specialization, between one branch of technology and another. He will organize and separate data, analyze and interpret it and transmit refined information to those who should receive it.

World Information Center

The other development—the concept of a mechanized information center—is most ingenious, indeed. Carried to its logical conclusion, it suggests the possibility of a world science information center. In such a center much of the useful knowledge from all technical disciplines would be stored in computers or other types of electronic or mechanical systems. From this center, research scientists would be able to draw the information needed for their studies. Or from it, production men and engineers in industry would be able to get the data required for their operational, design, specification and planning work. This information would be processed—organized and integrated—and made readily available to the user by a system as simple perhaps as the use of the dial of his telephone, which would set in motion the retrieval and transmitting system.

At the moment, such a development seems visionary. Perhaps the ideal of a world technical or science information center *is* far from realization. But it is worth working for. And the important thing to note is that the ASM is already making a step in this direction with its present literature indexing and searching service. Your Society now offers one of the most complete literature services extant, with coverage not only of metallurgy, but also of the related sciences and even business and economic literature. Is it not possible that right now you are in the pioneering stage of development of a world information center? In your present mechanized system you have the nucleus around which to build. And you have the people of *leadership* who can grasp the potentialities of such a development. Moreover, if one were to deliberately set out to create an all-inclusive technical information center, he would most likely start in the field of metals. So ASM is perhaps already in the evolutionary stage of a development, the full vision of which not only is breath-taking in its significance—but encompasses a magnitude of operations almost too great for a single organization to grasp.

Whether a world-wide all-inclusive technical information center comes about soon or late, I am certain that data processing will be important in the resolution of the communications dilemma. Machines and sophisticated techniques will make possible the storage, organization and recall of information so *it can be used*—so the results of scientific research are of benefit to mankind. This is the reason for scientific effort—the ultimate reason for the existence of organizations such as ASM.

As you pioneer such things as mechanized literature, searching new techniques of editorial presentation, the compression of information into handbooks, methods of liaison between technology and industrial management, and new educational programs, you are helping to forge more of the essential links needed for human progress. By these acts and deeds, consciously or unconsciously, you are fulfilling a role of destiny and validating the esteem you now enjoy in the eyes of your countrymen.

JERSEY—*Fourteen past chairmen of the New Jersey Chapter were guests at a recent meeting at which time they were presented the new ASM past chairmen's pins. Shown in the group photograph are: (front row, left to right) T. G. Gilley, 1949; W. Klaile, 1948; W. L. Hults, 1947; D. A. Butler, 1946; S. Skowronski, 1945; C. J. Wiegel, 1941; H. D. McKinney, 1931; (rear row) Anthony Scafati, 1960; John L. Everhart, 1959; Stanley Lindstrom, 1958; J. J. Hauptly, 1957; William C. Schulte, 1953; Alfred Bornemann, 1952; and John Ross, 1950.*

Value Analysis Strives to Lower Costs Without Impairing Product Quality

VALUE ANALYSIS IS DEFINED as the study of the design function and cost of any product, material or service, with the object of reducing its cost through modification of design or material specifications, manufacturing by more efficient processes, change in source of supply or possible elimination or incorporation into a related item. All this must be accomplished *without* lowering quality or impairing the salability of any product, material or service.

This definition was provided the *Milwaukee* Chapter ASM, by Jack Kenny, training director, International Harvester Co., at a recent meeting.

Industry today is caught between shrinking profit margins and increased costs of labor and material. In order to survive at a profit, industry obviously must find a means of reducing its costs in order to make a profit and remain competitive. A program of Value Analysis is the method employed to accomplish this aim. Since it cannot materially affect *manpower* costs it is primarily restricted to *material* cost reduction.

The key to value analysis is the word *function*. In other words, what can perform the same function just as well or better for less cost. The contingent concern of function is value, that is, the lower cost answer must perform the same function without reducing the value of the item in question. This can be accomplished by examining with an open mind the balance between its cost and functional value, and efforts are expended to reduce the cost side of the balance.

There are two main areas in which the principles of value analysis can be most successfully exploited. They are design engineering and purchasing. Design engineering personnel must constantly consider the function of any item and its cost, operating with this thought in mind; "What can perform the same function just as well, or better, for less cost?" Purchasing personnel can, through the use of price comparisons, take advantage of competition by selecting the proper vendor from a functional standpoint.

Six points that contribute an important aspect to this type of program are as follows:

1. *Habit*—Habitual methods of manufacturing or material usage are a primary factor in stopping progress. Continuously examine the needs of a particular situation and attempt to find a new method of solution, rather than to rely on older, probably-more-expensive methods.

2. *Attitudes*—Attitudes are many times the result of habits. A cooperative, objective attitude is necessary to obtain the full value from a cost reduction program.

3. *Lack of Information*—Base all decisions on proper data and thorough information—not on what the human animal may *think* or *believe* are the correct facts.

4. *Wrong Beliefs*—Many times people entertain a common belief that no longer is valid. For example, it is a common belief that plastics are brittle and will fracture when subjected to stress or shock. This is not a fact, as many plastics are ductile. This shows how wrong belief, coupled with habit, attitude and lack of information could result in the wrong decision.

5. *Lack of an Idea*—During the initial planning stages of a new product, material or service, one should try to select a solution from a multitude of ideas rather than having a single idea and following it through.

6. *Temporary Conditions* (the crash program)—One of the most costly mistakes in industry today is the crash program which results when speed is of the essence and other considerations are secondary. Too many times the crash method is left in operation when in all reality, as soon as the pressure eases, it should be completely re-examined and probably changed.

In large corporations of a multi-divisional nature, a major cost reduction area lies in the standardization of similar items used in the various divisions. Literally, millions of dollars could be saved by corporate-wide standardization of common high volume items.

As a direct result of divisional correlation, additional savings can be realized by consolidating requirements and buying in volume. Everyone is familiar with the fact that under most conditions, the greater the number of parts to be made on a mass production basis, the smaller the cost of each unit item.

The greatest stumbling block to a successful value analysis program is the result of various human traits. An example of these mental blocks is one known as "Fear of Failure". It can be readily reflected in product specifications wherein the designer-originator specifies materials, tolerance, finishes, etc., that are unnecessary for the function of the item. He does this as his own personally added safety factor, without real consideration of the additional costs involved.

Mr. Kenny described rather completely the actual workings of a value analysis group, pointing out that such a group must cross many organizational lines freely, have the full backing of top management, and that the basic motivation for each person engaged in the program must be the reduction of cost without the sacrifice of value or salability. *(Reported by Karl H. Kalsen.)*

METALS

Metal Producers Gird for Competitive Battles

Representative producers of leading metals are taking a variety of actions, all designed to gain, regain or defend markets. Some of these actions are fostered by groups within metals groups but many more are individual actions of the producing companies.

By now the actions of the steel industry in promoting the "Steelmark" are well known. More recently there has been formed a Committee of Aluminum Producers currently engaged in promotional activities designed to stimulate the use of aluminum in the marine field. Producers of copper and magnesium have been aggressive in developing new products and selling them to industry.

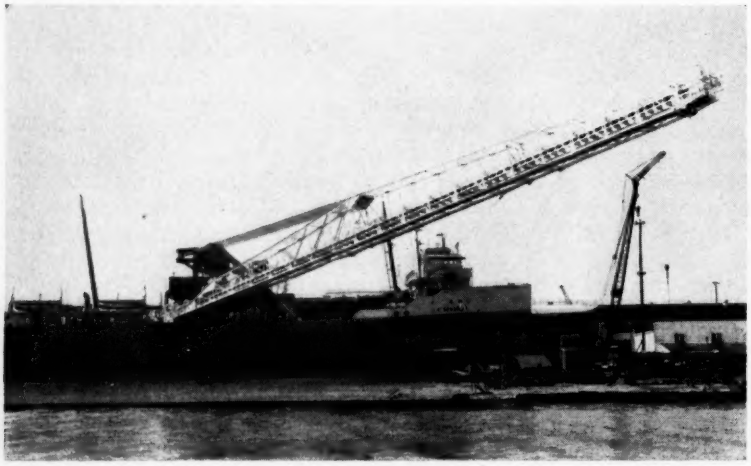
In the steel industry, particularly, individual companies have developed imaginative approaches to selling their wares. Here are some of the specifics:

United States Steel Corp. recently uncovered the results of a two-year industrial design program under the direction of Peter Muller-Munk. Objective of the program was to develop design concepts which would "enable steel to do a better job in more places". Results of the program, it is hoped, will be increased by the use of steels in office furniture, the institutional field, mass retailing facilities and applications for the home.

Another company, Sharon Steel Corp., is making it easier for potential customers to buy and use its textured steel by providing a design service to create special patterns according to the customer's needs. Design teams strive to find the proper metal and decorative pattern combination.

Even the lowly carbon steels have come in for attention to make them more competitive in today's markets. Modest additions of columbium to carbon steels work wonders in providing higher tensile and yield strengths without sacrificing weldability. The result is that both weight and cost savings can be attained on a multitude of products.

ALUMINUM BOOMS—*The self-unloading characteristic of the Great Lakes vessel J. R. Sensibac has been expanded by the installation of a 256-ft. long aluminum boom. The new boom, made of aluminum extrusions, is 60 ft. longer and 25 tons lighter than the one it replaced. Added length aids cargo spotting on Great Lakes ports. (Photo courtesy Alcoa.)*



The automotive market for metals is so great that producers go to great lengths to preserve or widen these markets.

For example:

With the threat of aluminum automobile radiators imminent, Chase Brass & Copper Co. has developed a new brass for such uses that are said to be lighter, less expensive and more enduring than brasses currently used for such applications. The new copper-base alloy offers 53% greater yield strength, 15% greater average tensile strength and 33% greater fatigue strength than conventionally used tank brass.

Magnesium has regained a major automotive use in the new Dodge Lancer. In this 1961 automobile, two magnesium die castings form the instrument cluster which surrounds instrument dials and provides the mounting for heater and automatic transmission buttons. A weight saving of approximately two-thirds resulted through the use of this light weight metal. In its final state, the magnesium assembly is painted in keeping with the car's interior décor.

No stranger to the use of designers to develop new markets for its products is the Aluminum Co. of America. One of the most recent examples is the development of a so-called Divertable, a highly imaginative and utilitarian game table. The table is one of a group of Forecast designs created for Alcoa which are to be made available to manufacturers.

In addition to competing against each other, metals groups are keeping an alert eye on competition developing among other materials, notably plastics.

Seek Improved Iron Making Process

A project which has as its objective the making practicable of a 75-year old ironmaking process has claimed the attention of Esso Research and Engineering Co. The

concept involves the use of hydrocarbons, particularly heavy oil of high heat content, which are injected into the bottom of blast furnaces. If successful, the process will increase furnace capacity and decrease costs of hot metal.

The scientific principles underlying the new development involve taking advantage of the chemical properties of oil as well as its heat producing ability. Oil, which contains hydrogen, contributes additional reducing gas to speed the reduction of ore into iron.

In early experiments, oil is injected into the furnace along with the heated air normally fed into the bottom of a blast furnace. The method has been tried, successfully, on both experimental furnaces and those in production.

Six 1961 Passenger Cars Offer Aluminum Engines

During the 1960 automotive year only one passenger car, the Corvair, had adopted an aluminum engine. The number will increase to at least six during the current production year.

In addition to Corvair, the Buick Special, Oldsmobile F-85, Rambler and Pontiac Tempest are already offering aluminum engines. Several models in the Chrysler line will use aluminum engines selectively before making a decision as to whether all of these lines will adopt the light-weight engines in later years.

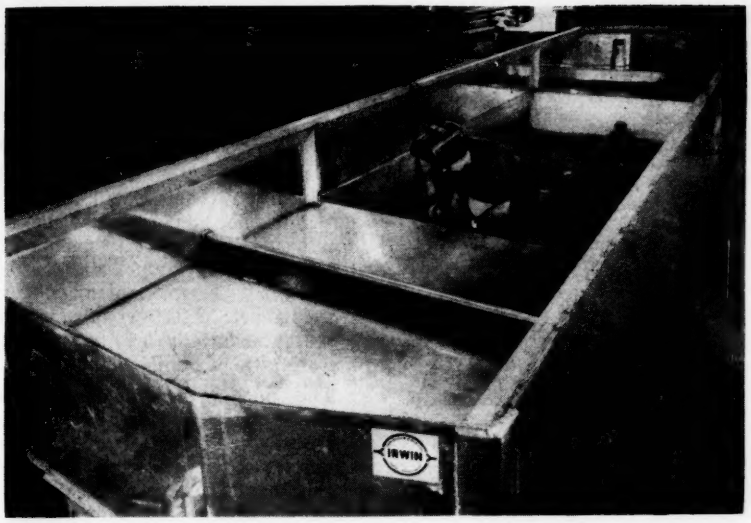
Almost as varied as their design are the production methods employed to produce the engines. Some are die cast, others rely on permanent mold casting and still others have selected semipermanent mold casting. Advances in foundry and die casting techniques are credited with the speed with which aluminum engines have replaced the historic cast iron engines. The trend has also been pushed by increasing stress on light weight as featured in the compact cars introduced widely last year.

Mine, Railway Cars Made of Aluminum

Chemicals, foodstuffs, refined ores and coal are now being hauled in aluminum cars, according to announcements made by two major aluminum producers.

Alcoa reports that aluminum mine cars are being installed in one of the largest coal mines in West Virginia. The new cars are 5000 lb. lighter than the cars they replace, thus permitting longer mine trains. A service life of 20 years is predicted for the mine cars.

From Canada, Aluminum Ltd. describes a new design of covered hopper cars which features aluminum construction. The cars feature curved sides to permit the least amount of metal to enclose the largest volume of space.



ALUMINUM MINE CAR—*A welder puts the finishing touches on the body of the first all-aluminum mine car. Manufactured by Irwin-Sensenick Corp., Irwin, Pa., the car is capable of carrying seven times its weight in pay load. Aluminum is used in all components except wheels, axles and couplers. (Photo courtesy Alcoa.)*

High Velocity Forming Improves Crystal Structure

Tremendous reduction ratios possible in forming tungsten by Dynapak machines has considerable effect on the crystal structure and strength of the metal. The high-velocity, high-pressure action of the forming machine has the effect of breaking up the large crystal structure. In ordinary extrusion, Convair engineers state, the large crystals are merely flattened. The large, common planes of the crystals weaken the metal and make it less resistant to shock or load.

Most work has been done on tungsten, but the same effect has been noted on titanium, molybdenum and other refractory metals. Dynapak is a machine developed by Convair for forging, extruding and compacting of metals. The machine can release explosive forces instantaneously.

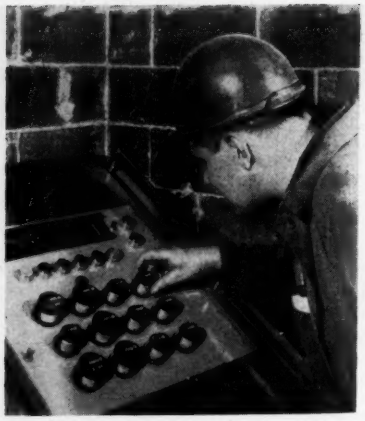
See Exotic Metal Use in Chemical Industry

The more exotic metals, tantalum, columbium, titanium and zirconium, which heretofore had limited use or were "little more than laboratory curiosities", have within the last ten years become available in increasing quantities at reduced prices, which "makes them attractive for corrosion resistant applications in the chemical industry".

This was the gist of a paper presented at a Corrosion Symposium during the 43rd National Meeting of the American Institute of Chemical Engineers by F. Fink, Battelle Memorial Institute, Columbus.

These metals have "outstanding resistance to a wide variety of media (and) can be both useful and economical in existing chemical processes", he said. While they are not a "cure-all" for all corrosion difficulties, they are becoming the preferred materials of construction for certain critical equipment components where shutdowns are frequent, loss of production is excessive and where maintenance costs are high".

Mr. Fink predicted that new design concepts should evolve in the future "which will make more efficient use of the versatility of one or more of these metals. A chemical process unit, manufactured from the most applicable one of these metals, should repay its high cost



COMPUTER HELPS CONTROL STEEL QUALITY—*A special-purpose analog computer which can calculate the proper ratio of hot metal, scrap and lime for the basic oxygen steelmaking furnace has been installed at the Aliquippa, Pa., works of Jones & Laughlin Steel Corp. Here, Jack Beal, melter, computes the proper ratio for the most efficient tapping temperature for a heat of steel.*

by the extremely long service that will be obtained".

New High Strength Steels Offer Ease of Fabrication

Metallurgists at Jones & Laughlin Steel Corp., Pittsburgh, have developed a new series of constructional steels which combine high strength with an ease of welding and forming never before available.

J&L engineers believe the new series, Jalloy-S, will permit builders of advanced and heavy-duty equipment to increase the strength of their products while effecting important savings in time and fabrication expense. The new constructional steels are expected to find wide acceptance in applications such as missiles, ordnance, off-the-road construction machinery, hoists, cranes and other industrial equipment, and as components in heavy trucks and farm machinery. Three steels in the series provide minimum yield strengths of 90,000, 100,000 and 110,000 psi.

A new companion series of steels, Jalloy-AR, feature high abrasion resistance at high yield strengths, according to J&L. This steel is expected to find wide application in components of equipment for mining, transportation and construction industries, among others. Typical yield strength is 140,000 psi. in two high hardness ranges.

Alloy Steel Developed for Antismog Devices

Development of a new alloy steel specifically for service in automobile antismog devices now being developed to meet requirements of California's new air pollution legislation has been announced by Armco Steel Corp. Cost is reported to be substantially less than other materials now being evaluated.

The new proprietary stainless grade is nominally 21% chromium, 6% nickel and 9% manganese. It is a modification of an alloy steel developed previously by Armco for exhaust valves in modern high-compression engines—which must withstand temperatures as high as 1200-1400°F.

The material of construction for either of two types of device must have high strength at elevated temperatures, good heat and corrosion resistance and be unaffected by lead salts in exhaust gases. Tests to date indicate Armco 21-6-9 to be superior to and less costly than most standard grades of stainless steel considered for antismog devices.

NONMETALLICS

Seek Answers To Ceramic Brittleness

A fundamental research program to determine the basic factors that influence the fracture of nonmetallic ceramic materials has been started by Armour Research Foundation under sponsorship of the Wright Air Development Division's Materials Control. The 18-month study, unique in its size and administrative aspects, will be conducted by a team of ARF researchers in physics, ceramics, metals and mechanics, and by eminent scientists at universities and industrial research laboratories in the United States and Europe.

Primary purpose of the research is to develop an understanding of the complexities involved in the fracture of inorganic, nonmetallic ceramics. Researchers will try to find out why ceramic materials fail, how they fail and what methods can be developed to improve their reliability.

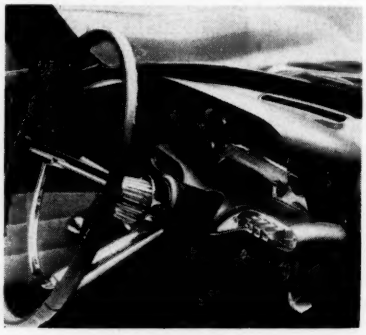
The ceramic materials to be used will be subjected to such influences as various stress fields, strain-rates, corrosive attack, temperatures, prior loading history, and surface active environments (e.g., neutral or oxidizing atmospheres, steam, small admixtures of acid vapors).

A thorough investigation will be made to find out how these influences affect ceramic materials containing different levels of impurities, various grain sizes and varying shapes and configurations.

Nicholas A. Weil, ARF director of mechanics research and project manager for the program, said the study will be principally concerned with metallic oxides, represented by single crystals and multicrystalline forms of magnesia and alumina. In addition, titanium oxide, silicon dioxide, titanium carbide and lithium flouride also will be explored.

Principal investigators for subcontract tasks will be N. J. Petch, professor of metallurgy at the University of Durham, England; E. Orowan, George Westinghouse professor in materials research and A. H. Stroh, professor of metallurgy, both of Massachusetts Institute of Technology; Ivan B. Cutler, head of the department of ceramic engineering and Peter Gibbs, associate professor of physics, both of the University of Utah; J. E. Burke and R. J. Charles of the General Electric Research Laboratory, Schenectady, N.Y.; R. J. Stokes, principal research scientist at the Hon-

MAGNESIUM IN AUTO DASH—*In one of the major automotive uses of magnesium, the light metal surrounds instrument dials and provides the mounting for the heater and automatic transmission buttons on the Dodge Lancer. The magnesium part is made of two die castings and weighs only 3¾ lb.*



eywell Research Center, Hopkins, Minn., and G. T. Murray, research scientist, Materials Research Corp., Yonkers, N.Y.

New High-Temperature Compounds Are Introduced

Its entry into the field of high-temperature refractory compounds has been announced by National Carbon Co., division of Union Carbide Corp. The announcement came with the introduction of titanium diboride shapes of unusual strength, size and purity. Other refractory compounds are to be marketed later, the company states.

A special process to reduce the oxides of titanium and boron produces an extremely fine, high-purity powder that is then fabricated into various shapes. Cylinders 6 in. in diameter, 20 in. long, weighing 100 lb., and 14 in. in diameter, 10 in. long, weighing 260 lb., have been produced. These are the largest shapes of this high-temperature, high-strength material ever made.

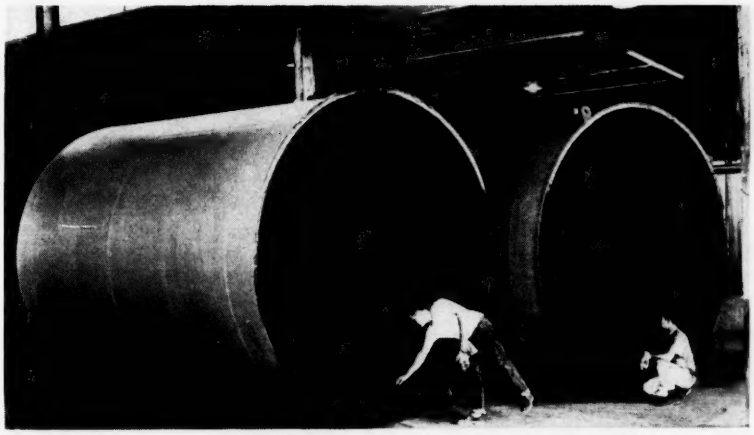
Most high-temperature materials begin to weaken seriously above approximately 1500° C., but National Carbon's titanium diboride maintains a flexural strength of 35,000 psi. over the wide temperature range of 25 through 2000° C., making it the strongest material known at these elevated temperatures. It has a high modulus of elasticity, similar to ceramic materials. Its weight is approximately half that of stainless steel and only 12% greater than alumina. Because of these properties, one possible use for titanium diboride is as lightweight ball and roller bearings for equipment such as jet and rocket engines that operate at elevated temperatures.

The hardness of titanium diboride is in the range of boron carbide, long regarded as the hardest man-made material. Although its hardness makes fabricated titanium diboride virtually unmachinable except with diamond tools, intricate shapes can be machined with conventional tools during the processing stages.

Titanium diboride has excellent resistance to oxidation at temperatures as high as 1000°C., and a relatively low oxidation rate even at 1400°C. It is inert to molten aluminum, molten zinc and molten slags, but is not resistant to molten ferrous metals. These properties suggest titanium diboride crucibles and pumps, tapping spouts, funnel linings, valves and gates for nonferrous metals, especially aluminum.

The company's production techniques result in titanium diboride of extremely fine and uniform particle size, and with a purity as high as 99.5%. Shapes have been produced with as high as 99% of theoretical crystal density.

BIG NEWS IN TANK LINING—*These steel acid tanks, 10 ft. in diameter and 15 ft. high, are among the largest to be coated with a seamless lining of polyvinyl chloride plastics. Here workmen inspect the 125-mil thick coating which was applied in liquid form and then baked to bond it to the steel backing. (Photo courtesy Metal & Thermit Corp.)*



Uranium Compounds Surveyed as Nuclear Fuels

Uranium mononitride, uranium sulphide and uranium silicides are potential reactor fuels which could provide a big payoff from increased research, according to a Battelle Memorial Institute report presented before the Joint ASM-AEC Conference at the National Metal Congress.

The report, prepared by Battelle reactor metallurgist R. F. Dickerson, critically evaluates all uranium compounds with the objective of picking those compounds which would produce the most return per research and development dollar invested.

Because of the advanced state of their technology, uranium dioxide and uranium carbides were mentioned as having the greatest current potential. However, according to Dickerson, uranium mononitride, uranium sulphide and the uranium silicides could well be developed into reactor fuels which would help provide economic nuclear power. Uranium beryllide (UBe_{13}) should also be considered worthy of a research and development investment, even though it would be suitable only for use in a compact reactor system. Uranium borides prepared with boron-11 should also be seriously considered.

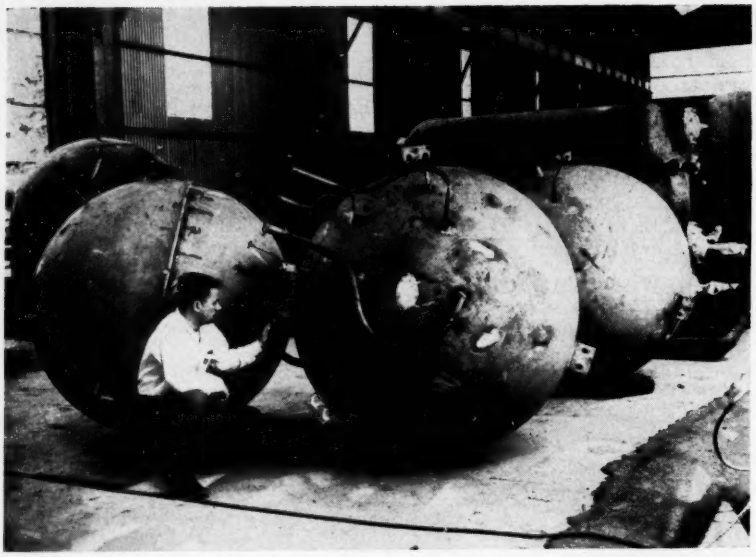
The criteria used to eliminate compounds from consideration were chemical instability, low thermal-neutron efficiency, low uranium density and low melting point or a combination of these properties. On the basis of these criteria and other available data, the materials listed were chosen from 62 uranium compounds.

INDUSTRIAL HEATING

Merits of Short-Cycle Heat Treatment Cited

For many years a rule of thumb has had strong influence in heat treatment of steels, according to Dale L. Hall, works manager, Oklahoma Steel Casting Co., Tulsa. He was referring primarily to the rule which indicated one hour of heat was required for each inch of maximum cross section of the piece being heat treated.

However, he told the *Texas Chapter* in Houston, developments in temperature recording devices and improved circulation in furnaces have obsoleted the hour per inch law, because it is no longer required.



CRYOGENIC TANKS—*Tanks for the storage of liquid oxygen are being made of carbon steel exteriors surrounding sheets made of 9% nickel steel alloy. Hemispheres of the new alloy are said by the fabricators, Big Three Welding Supply Co., Fort Worth, to represent a minimum saving of $1,500 over similar storage tanks made of stainless steel or aluminum. Inner sheets are made by Lukens Steel Co. and shipped to Texas for final assembly.*

In fact, Hall stated, recent investigations have clearly established that unnecessarily long holding times at a given heat treat temperature might even be detrimental.

Recent research on seven cast steels of widely varying compositions shows that it is not necessary to homogenize any of these steels if a quench and temper treatment is to follow. Too, the research indicated that it is not necessary to hold these steels for long periods at elevated temperatures before quenching. Fifty to 100°F. above the upper critical temperature for only 15 min. is a sufficient soaking period.

In tempering quenched steels, Hall said, both time and temperature are important in short-cycle heat treatments. For example, in chromium-molybdenum cast steel heat treated to 25 Rockwell C, tempering at 1300°F. for 18 min. produced better properties than a tempering treatment at 1200°F. for 12 hr. Heat treatments were evaluated by Charpy V-notch tests at room temperature, at —40 and —80°F. and through tensile tests at room temperature.

In addition to producing better properties, short-cycle heat treatments are more economical, Hall concluded.

FINISHING & COATING

Color Coating Is Suited to Most Metals

A new chemical surface treating process, which for the first time color coats all types of metals in a single treatment, is now ready for commercial application, Pennsalt Chemicals Corp. has announced. Called the Hinac Process, the new coating is produced in several grades, clear and colored, which are corrosion resistant, have good weathering properties and are color fast. The process combines ease of application with good corrosion resistance at economical cost.

The Hinac Process, along with pertinent patents, has been acquired by Pennsalt from the Heintz Division of the Kelsey-Hayes Co., with whom Pennsalt has been collaborating in the development of products and processes for metal treating for a number of years.

The Hinac Process was shown to the metal trades for the first time at the 1960 National Metals Exposition and Congress in Philadelphia. Hinac coatings can be applied readily to practically any metal, producing attractive satin and color finishes. In addition to being resistant to acids, alkalis and solvents, the color coatings are considerably more economical than color anodizing or painting.

Hinac coatings are applied in aqueous solution at room temperatures. The only pretreatment required is thorough cleaning and rinsing, as would be done in any finishing system. Curing time can be as little as a few seconds, depending on the heat source. Three coatings are available.

Color Hinac, available in a hard, solvent-resistant grade and a ductile grade, provides both under film corrosion resistance and attractive, lightfast color. Applied to aluminum, zinc, carbon steel, stainless steel, magnesium and other metals, Color Hinac finishes are hard, durable and resistant to salt spray. When exposed to Florida sun for a full year and 2000-hr. weather-meter tests, such Hinac-coated metals exhibited good weathering, fade resistance and gloss retention.

Electron Beam Source Aids Vapor Coating

Adaptation of electron bombardment heating sources to standard and special vacuum coaters for research into the evaporation of ultra-pure metals and alloy systems, as well as for depositing high-temperature materials, such as zirconium, tantalum and tungsten, has been achieved by NRC Equipment Corp., a subsidiary of National Research Corp.

According to the company, any of its standard coaters can be supplied with electron bombardment evaporation sources, consisting of an electron gun or annular ring, being used as the heating source. Evaporation paths can be controlled by the relative position of the gun and of the metal to be evaporated. The latter can be mounted either as an ingot or button on a copper, water-cooled support. The gun can be located either on top or on the side of the chamber and is rated at up to 6 kw.

With conventional coaters, it has been difficult or impossible to deposit reactive and refractory materials under vacuum because of the lack of a practical method of holding and heating them to their vaporization temperatures. With an electron beam source—either a ring or a gun—the top operating tem-

perature is practically unlimited, and the bulk material can serve as its own container. Hence, it is now possible to evaporate almost any material, including those of special interest for electronic research on thin films, for investigation of the bulk properties of high-temperature alloys, or simply for coating missile and industrial components with highly corrosion or heat resistant surfaces.

FORMING & SHAPING

Electrochemical Machining

A revolutionary new method of removing metal from difficult-to-machine parts, such as aircraft and missile components, has been announced by the Steel Improvement and Forge Co., Cleveland. The new process is expected to answer a number of critical problems created by the hard, tough and frequently heat-sensitive materials which have now come into use.

Those concerned with the development of the new process believe it can be adapted to many shaping operations normally performed with standard machine tools. Shapes now created by lathe turning, form grinding, internal shaping, broaching and drilling appear suited to electroshaping.

In the new metal removing method, to which Steel Improvement has given the name "Sifco Shape", a cube-shaped, plastic-fabricated chamber is used to hold the part to be machined plus electrodes made in the size and shape to be duplicated. An electric current, passed from workpiece to electrodes through a rapidly flowing chemical solution, does the metal removing. There is no metal-to-metal contact, and no "tool" wear, as with other machining methods.

The rate of metal removal is governed by the amount of electric current applied, and varies with the type of metal to be machined and the work area to be covered.

The new electroshaping process was developed from research sponsored by Steel Improvement at Battelle Memorial Institute. The equipment developed is now well out of the laboratory stage. Several of the new machines set up and operating on a production basis in one of Steel Improvement's Cleveland plants for a number of months have successfully produced more than 15,000 jet engine compressor blades across 16 different designs. The new process has come along so well the company is now at the point where tooling can be produced by similar techniques.

In demonstrations, Steel Improvement technicians contour-machined jet engine compressor blades electrochemically from raw forgings into precision-finished components in a matter of minutes — many times faster than can be done by conventional machining methods.

The work so far carried out has been largely concentrated on electroshaping workpieces which have been forged, but the process is expected to be as readily applicable to machining castings and bar stock. Airfoils with leading and trailing edges as thin as 0.005 in. are being produced. Contour control is good, reproduction is excellent and savings in machining costs are significant.

SUPER ALLOY SPRING— *One of the interesting sights of the recent National Metal Exposition in Philadelphia was this 5½ ft. long spring made of Inconet-X wire. The ultimate use of the $200 spring is classified, although it is known that it must operate continuously at temperatures of about 500°F. The ¼ in. diameter wire is coiled into a spring diameter of about 2¾ in. by Hoosier Spring Co. (Photo courtesy National-Standard Co.)*

PARTS & FORMS

U. S. Share of Steel Extrusion Output Drops

The U.S. steel extrusion industry is growing uneasy over recent production figures that show them lagging behind their foreign competitors. The information was provided them during a recent three-day conference in Beaver Falls, Pa., at the Babcock and Wilcox Co.

Two years ago, according to the unpublished report, the United States produced half of the total world tonnage of extruded steel products. Since 1958, world production figures show a 120% increase in tonnage, while U.S. production figures have remained relatively constant. Figures for 1960 show that the U.S. is now producing only 21% of the total world tonnage, compared to 50% in 1958.

The most startling figures describe the rapid strides of the Japanese companies producing steel extrusion products. One year ago they were not yet in production. This year they account for 29% of total world tonnage produced.

The figures were released by a representative of the Compagnie du Filage des Métaux et des Joints Curty, M. Rene Hubert, who presented the report to the American firms. The French company is a subsidiary of Ugine, France's largest producer of special steels. Ugine developed the patented Ugine-Séjournet process for the hot extrusion of steel.

The process can be used with ordinary steel, alloy steels, stainless and heat resisting steels. It can also be applied to high-nickel alloys, and such metals as molybdenum, titanium and zirconium.

The process has been licensed for use by 34 companies in Austria, Canada, France, Germany, Great Britain, Italy, Japan, Spain, Sweden and the United States. In this country 13 companies are licensed to use the process. Six of them participated in the conference which was hosted by Babcock and Wilcox, the first company licensed to use the process. The others at the meeting were: Allegheny Ludlum Steel Corp., National Tube, H. M. Harper, Jones & Laughlin, and International Nickel.

Role of Metallurgical Engineer in Research Is Defined

A PROPERLY QUALIFIED YOUNG METALLURGICAL engineer in research is gambling with a deck stacked in his favor, according to Orville T. Barnett, assistant director metals research, Armour Research Foundation. His statement was made before the Metals Club of the Illinois Institute of Technology.

"The fastest growing American industry is large-scale research and the most rapidly expanding markets—the markets for new products, new materials, new know-how", observes Wassily Leontiff in his introduction to Leonard Silk's new book, "The Research Revolution". In 1940 the United States spent $350 million for research and development. In two decades the R&D budget climbed to an estimated $13 billion for 1960. This is a growth of 37 times in a short span of years. Couple this explosive growth with the sobering fact that the demand for trained metallurgists is outstripping the supply and the choice of a career in metallurgical research is made easily.

Where does the research metallurgist work? He plies his trade in industry, at universities, in independent research organizations (such as Armour Research Foundation of the Illinois Institute of Technology), for government, with trade associations or on the staff of private foundations.

While much metallurgical research has been done by the primary metal producers, their rate of effort has been tremendously expanded of late. Every major steel producer has new research laboratories in being, in the process of expansion or under construction. Most of this facility construction and staff build-up took place during the 1950's. A nearly similar situation obtains for the nonferrous metal producers. The American Iron and Steel Institute has a yearly research budget of over a million dollars, and the nonferrous trade associations, such as the American Zinc Institute, the Copper Producers Development Association and the Lead Industries Association are devoting large sums to metallurgical research. Metals are protecting their future against the other materials and, at the same time, are jockeying for position against each other.

Opportunities are lush and the thick grass is green for metallurgical research engineers who possess the proper equipment. In research, advanced degrees are in high demand. While knowledge is more important than mere sheepskins, a combination of both is a dandy qualification.

Metallurgists in research must be creative. They should understand how to write and speak clearly and effectively. While they may not have found time for psychology, philosophy and other useful areas of broad educational need in their crowded technical curricula, these subjects should be pursued in spare time reading. Opportunity in metallurgical research is knocking many more times than twice. Salaries are zooming. Great is the recognition of accomplishment. If a young metallurgist has *real* ability, he can go far—with amazing speed—in research.

Describes Atlas Missile

THE MATERIALS APPROACH TO THE ATLAS missile was described as "unsophisticated" by Abraham Hurlich, chief of the materials research group, Convair Astronautics, before the *Long Island* Chapter. The use of standard commercial materials wherever possible has contributed much to the missile's dependability.

The basic 100-ft. long, 10-ft. diameter tank body is made from aluminum alloys and Type 301 stainless steels. Liquid oxygen plumbing is fabricated from "K" Monel sheet, mostly through automatic welding. Titanium alloys are used in the low-temperature pressure bottles.

A unique design feature of the Atlas is the lack of compression loading. The complete tank body structure is designed as a tension cylinder and, as such, requires constant pressurization during fabrication.

Because the missile is liquid fueled, its structure is at cryogenic temperature prior to and during its flight. For this reason, Convair designers have utilized the higher yield strengths of materials at low temperatures in their design calculations. Thus they have achieved a lighter structure than would have been true if room temperature specification minimums were used.

Metals Terminology

Definitions of metals, processes and thermal treatments selected from the 8th Edition of ASM's Metals Handbook

Air-Hardening Steel—A steel containing sufficient carbon and other alloying elements to harden fully during cooling in air or other gaseous mediums from a temperature above its transformation range. The term should be restricted to steels that are capable of being hardened by cooling in air in fairly large sections, about 2 in. or more in diameter. Same as self-hardening steel.

Equilibrium Diagram—A graphical representation of the temperature, pressure and composition limits of phase fields in an alloy system as they exist under conditions of complete equilibrium. In metal systems, pressure is usually considered constant.

Nitriding — Introducing nitrogen into a solid ferrous alloy by holding at a suitable temperature (below Ac_1 for ferritic steels) in contact with a nitrogenous material, usually ammonia or molten cyanide of appropriate composition. Quenching is not required to produce a hard case.

Refractory Metal—A metal having an extremely high melting point. In the broad sense, it refers to metals having melting points above the range of iron, cobalt and nickel.

Shortness—A form of brittleness in metal. It is designated as "cold", "hot", and "red", to indicate the temperature range in which the brittleness occurs.

White Metal—(1) A general term covering a group of white-colored metals of relatively low melting points (lead, antimony, bismuth, tin, cadmium and zinc) and of the alloys based on these metals. (2) A copper matte of about 77% Cu obtained from the smelting of sulphide copper ores.

Reader Outlines History of Alpha Sigma Mu

To the Editor:

I was delighted to read in the June issue of *Metals Review* of the establishment of the fourth chapter of Alpha Sigma Mu at Missouri School of Mines and Metallurgy. Also, that members at large have been elected into ASM from more than 30 colleges and universities in the USA.

Alpha Sigma Mu floundered for many years and I was pleased when the American Society for Metals took the honorary under its wing and lent active aid in establishing new chapters, as well as strengthening the fraternity and helping it gain wider acceptance. The fraternity was originally founded on the basis of recognizing scholastic attainment. Because of comparatively small classes of metallurgical students, the elected membership was limited in numbers and the fraternity was not very active on local campuses. Professor Gilbert Boyd of MCM&T nursed the fraternity along for many years but colleges and universities with curricula in metallurgy showed little interest in establishing local chapters.

The American Society for Metals' decision to sponsor Alpha Sigma Mu was appropriate since the Greek letters naming the fraternity were lifted directly from ASM originally. In the case of the fraternity, the Greek letters were designated to mean "Arts and Sciences of Metals". In the early 1930's chemical metallurgy was more popular than physical metallurgy, which accounts for the gold nugget that appeared on the key.

Alpha Chapter was founded at Michigan College of Mining and Technology in January 1932. Beta Chapter was chartered at University of Illinois, January 16, 1940. I do not remember the date of Gamma Chapter at Virginia Polytechnic Institute but Michael Nevitt of VPI's faculty was the prime mover. Mike was a member of Beta Chapter at Illinois. For the records, the charter members of Beta Chapter were Charles R. Brummett, Ralph E. Herzler, Robert L. Hogue, John Olivieri, Milton R. Rearich and Joseph L. Wiseman.

The founding of Alpha Sigma Mu replaced an existing organization known as the "Ingot Club" at Michigan Tech. The Ingot Club was a technical organization and held meetings where technical papers were read. Alpha Sigma Mu limited membership to certain scholastic attainments in metallurgy. Elected members were required to read an acceptable technical paper, usually based upon original research, at the time of initiation.

I remember some very good papers being read and wonder if this is still required for membership.

My interests in Alpha Sigma Mu stem from writing the original by-laws and constitution, and as the incorporator under the nonprofit laws of the State of Michigan.

Harold L. Walker
Director of Research
The University of New Mexico
Albuquerque

PHILADELPHIA INSTRUCTOR HONORED—*Fred B. Money (center) is shown receiving a citation, signed jointly by the National ASM officers and the Philadelphia Chapter Chairman, commending him for 27 years of faithful service as an instructor in the Temple-ASM evening metallurgy course. J. B. Giacobbe, Philadelphia Chapter Chairman, is making the presentation while C. B. Metzger, representing Temple University, looks on.*

Discusses Steel's Competitive Materials

"SOME MATERIALS COMPETITIVE WITH STEEL" was the talk presented before members of the *Canton-Massillon* Chapter at its October meeting by K. B. Valentine. The speaker is a metallurgical engineer for Pontiac Motor Div., General Motors Corp., Detroit.

Mr. Valentine stated that in keeping with the practice and thinking of Pontiac Motor Div., the two main reasons for the selection of material were, first, the part must function properly and, second, the material must be economically competitive. These materials were subdivided into nonmetallic materials and metallic materials.

Nylon was one of the first nonmetallic materials used as a replacement for steel. Some of the nonmetallic materials discussed by Mr. Valentine were gunk molding compounds, which are polyester resins, ceramics and rubber compounds.

Aluminum is steel's largest competitive metallic material. Some factors in considering aluminum are low inertia, appearance, ease of manufacturing, corrosion resistance and cleanliness after extrusion. Copper alloys were also mentioned as a competitor of steel.

During his discussion, Mr. Valentine presented samples from actual automobile parts to demonstrate the use of nonmetallic and metallic materials which are competitive with steel. *(Reported by J. J. Donze for the Canton-Massillon Chapter.)*

Proposes Definition of Nuclear Metallurgy

THE STUDY OF MATERIALS BEHAVIOR in nuclear reactor environment was proposed as the definition of nuclear metallurgy by Benjamin Lustman, manager—reactor metallurgy, Bettis Atomic Power Lab., Westinghouse Electric Corp., in a talk entitled, "The Application of Materials in Nuclear Reactors" before the *Pittsburgh Chapter.*

Nuclear materials must not only withstand the usual conditions of temperature, corrosion and stress encountered in common applications but also the deteriorating influence of fields of nuclear particles. Fast neutrons and fission fragments are particularly important with respect to their effects on nuclear materials properties. Bombardment by fast neutrons results in structural damage to nuclear materials, principally by atomic displacements. Fission fragments cause damage effects by incorporation of the fission fragments within the material structure, by ionization effects and by producing highly localized displacements.

Dr. Lustman illustrated by means of slides the effect of fission fragment bombardment on the electrical resistivity of a random body-centered cubic form of an uranium—13.5% molybdenum alloy. The decrease in electrical resistivity of irradiated samples as compared to unirradiated samples over a temperature range was interpreted to indicate a partial ordering of the random solid solution as a result of the enhanced diffusion rate resulting from the bombardment. In a similar manner, it was demonstrated that the ordered structures in certain uranium-molybdenum alloys could be effectively destroyed by fissioning. The contrasting effects of nuclear bombardment on alloys which form ordered phases with those in which no ordered phases exist was further illustrated in a slide depicting two uranium-base alloys: one a uranium—12% molybdenum alloy in which ordered phases can form and the other a uranium—10% columbium alloy in which no ordered equilibrium phases are detected. In the former case, fission fragment bombardment caused a decrease in electrical resisitivity, in the latter, an increase in electrical resistivity.

In addition to stabilizing phases which ordinarily would not be anticipated to exist and structures which cannot be duplicated by other known processes, nuclear environments cause marked changes in the mechanical properties of the common metallic materials such as low carbon and stainless steels and zirconium alloys. The exposure of these materials to fast neutron bombardment increases yield strength markedly, increases to a lesser extent their ultimate strength and reduces uniform elongations to extremely low values. Materials, such as carbon steels, which show a ductile-brittle transition temperature in the unirradiated condition show a continuous elevation of the transition temperature with increasing exposure to fast neutrons. Although materials that do not show a ductile-brittle transition in the unirradiated condition are not embrittled in the irradiated state no matter what the dosage of fast neutrons, brittle behavior can result due to the formation of certain types of transmuted atoms. Gas-producing reactions are particularly harmful to the ductility of austenitic stainless steels and aluminum.

Corrosion rates in nuclear environments have been found to differ inappreciably from those observed under out-of-pile conditions. Dr. Lustman pointed out, however, that there have been several instances in which irradiation has induced corrosion effects which not only were not observed out-of-pile but were not thermodynamically feasible outside a reactor environment. A particular example cited was that of UO_2 exposed to hot water in-pile in a reactor. UO_2 is thermodynamically nonreactive with reactor water, however, UO_2 when exposed to water, at temperatures corresponding to those of the out-of-pile exposure suffered severe corrosion attack. This effect is explained by the interaction of charged nuclear particles with the water.

Dr. Lustman concluded by attributing the successful operation of power reactors to the ability of nuclear metallurgists to cope with the many and complex problems in adapting materials for use in nuclear environments. *(Reported by D. K. Fox.)*

RECEIVES CHAPTER AWARD—*Sumio Yukawa (left), General Electric Co., receives Alfred H. Geisler Award from Professor Wiley Childs of Rennsselaer Polytechnic Institute, Troy, N.Y. Dr. Yukawa is chairman of Eastern New York Chapter.*

The 1960 award was granted to Dr. Yukawa in recognition of his outstanding contribution to the metallurgical profession through studies and applications of the principles of mechanical properties of metals with special emphasis on the brittle behavior of structural alloy steels. The purpose of this award is to recognize significant achievement by a member of the Eastern New York Chapter in the fields of education, research and manufacturing as applied to the metallurgical profession.

Recent Developments in the Space Age Alloys Traced by Speaker at Utah

BECAUSE TOUGHNESS OF STEELS has been considered to be inversely proportional to hardness, engineers, until recently, did not use low-alloy steels at maximum hardness or at extremely high tensile strengths. The combination of low toughness and high notch sensitivity caused serious concern among engineers designing structures subjected to impact or dynamic loading. These points were stressed by A. P. Terrile, Crucible Steel Co. of America, in a talk before the *Utah* Chapter on "Ultra High Strength Alloy Steels, Stainless and Some Super Alloys Designed for the Space Age".

Studies in 1945 by Crucible's research metallurgists, P. Payson and A. Nehrenberg, of the effects of silicon in tempering of alloy steel, led to the announcement of Crucible's ultra-high strength steel "Hy-Tuf". This may be considered one of the original ultra-high strength low-alloy steels as the constitution resulted in an alloy of high toughness and over 30 ft. per lb. Charpy V-notch impact when heat treated to a high tensile strength of 230,000 psi.

Reliability is a factor of greatest importance. Even in the best air melt electric furnace practices, transverse properties cannot be guaranteed to assure consistently high toughness, particularly at strength levels above 250,000 psi. In the last year the aircraft industry's concern over the unreliability of air melted steels has been responsible for the use of more and more vacuum melted ultra-high strength steels.

The H-11 family of hot work toolsteels has also received considerable attention among advanced aircraft and missile manufacturers. This is because weight savings can be achieved as these steels may be heat treated to over 300,000 psi. strength level and because they also show good resistance to softening at temperatures up to and including 800°F

Stainless steels of various types are also used in advanced missile and aircraft applications where their high strength and heat resistance properties make them valuable.

GETS CHAPTER MEMENTO —*A. P. Terrile (left) receives the Utah Chapter's beehive memento from B. R. MacKay (right) in recognition for his talk "Ultra-High Strength Alloy Steels, Stainless and Some Super Alloys Designed for the Space Age". C. K. Bentley, technical chairman, looks on.*

Not only metals, but many other materials, such as glass combinations, resins, plastics and graphitics, are being scientifically studied for their parts to play in the ultimate success which will be inevitably attained in future designs of missile and space vehicles. *(Reported by Ralph R. Hitchcock.)*

Oxygen in Steelmaking to Increase Many Fold

Necessity is forcing the ever-increasing use of oxygen in iron and steelmaking, according to A. L. Hodges, Gas Process Development, Linde Co. Hodges spoke on "Oxygen in Iron and Steelmaking" before the *Wilmington* Chapter. This necessity has resulted in considerable research and development devoted to the use of oxygen in accelerating chemical reaction rates. As a result of this study it has been demonstrated that the ordinary openhearth can be revolutionized to practically a pneumatic operation.

Increased production from the iron blast furnace, for example, can be accomplished by oxygen enrichment which increases the furnace driving rate or ability to generate high-temperature heat. Research has shown that specific conditions of blast temperature, oxygen control and injected natural gas can provide an increase in production of 20-30% or more. In addition, it can be shown that these same conditions will reduce the rate of consumption of coke by 200-300 lb.

In converting iron to steel, oxygen again plays a major role in economical operation. The benefits of using oxygen in the bessemer process to enrich the air blast which burns out the carbon and silicon are that the scrap capacity can be increased and that the blowing time can be shortened. In the openhearth process, oxygen in large quantities has been found very effective in attaining increased furnace output and lower fuel consumption. Oxygen is effective in decreasing refining time by permitting direct oxidation and by allowing much higher fuel firing rates.

For example, actual furnace tests during the past year have shown that with an oxygen consumption of 500-1000 cu.ft. per ton of steel, production was increased as much as 50-100% with fuel savings of 25-65%. Although many extremely fast heats of the past summer have been considered "trick" heats, such as those making well over 100 ton per hr., it could well be that the trick heats of today will be standard practice tomorrow.

In summary, Mr. Hodges spoke on the future growth of oxygen usage in the steel industry. Average oxygen consumption for all steel is currently about 400 cu.ft. per ton of ingots. This could well exceed 1000-1500 cu.ft. per ton within the next decade and 500 to 7000 cu.ft. per ton within the next 25 years. The realization of these rates of consumption rests on full employment of imagination and study by both the oxygen and steel producers. *(Reported by G. D. Smith.)*

CHAPTER BRIEFS

The importance of the mineral industry to the Canadian economy was explained to members of the *Ottawa Valley* Chapter by T. H. Janes of the Mineral Resources Div., Dept. of Mines and Technical Surveys, Ottawa, Ont. The value of Canadian mineral production reached a new high of $2.4 billion in 1959. Statistics provided by Mr.

(*Continued on page* 18)

Janes indicated that further processing of Canadian minerals and metals to the ultimate stage of secondary manufactured products would be of great benefit to the Canadian economy.

Representatives of three area industries featured the Indianapolis night meeting of the *Indianapolis* Chapter. Their purpose was to tell about the companies and their products. Speakers and their companies were: Earl Larsen, director of engineering, Mallory Metallurgical Co.; W. H. Steed, special accounts manager, Cummins Engine Co., Inc.; and George R. Sippel, assistant plant metallurgist, Allison Div., General Motors Corp.

The design and manufacture of costume jewelry was described to members of the *Peoria* Chapter and their wives at the Chapter's annual Ladies' Night Dinner. The speaker was Marvin Belkin representing Trifari, Krussman and Fischel, Inc., manufacturers of this type of jewelry. The audience was highly interested in the tools of the manufacturing jeweler which included dentist drills, eyebrow tweezers and hypodermic needles. Ladies in the audience were particularly impressed with the modeling of new jewelry by a member of the firm's style consultant staff.

Worcester Chapter featured a panel on Heat Treatment of Steel at its October meeting. Participating were: technical chairman, Edward F. Grady, C. I. Hayes, Inc., and panelists, William Pine, chief metallurgist, C. I. Hayes, Inc., Allen Shepard, chief metallurgist, Taft Pierce Co., and George Schubert, vice-president, Schubert Heat Treating Co.

Applications of powder metallurgy were discussed before a meeting of the *New Haven* Chapter by Lloyd E. Raymond, manufacturing engineering laboratory, Singer Mfg. Co. Mr. Raymond is a longtime member of the New Haven Chapter and has served in the complete range of offices in the chapter. In addition to discussing the history of powder metallurgy, Mr. Raymond stressed current industrial uses.

Lubrication is the limiting factor today in many machine operations, according to R. M. Kipp, Sun Oil Co., speaking before the *Tri-City* Chapter. Speaking on "Wear and Friction, the Vital Role of Lubricants" he indicated that future lubricants might be solids, liquid salts, liquid metals or gases, particularly in service involving high and low temperature.

Oil field tools are designed to wear out before they fail, members of the *North Texas Chapter* were told by H. M. Rollins, engineering manager, Drilco Oil Tools, Midland, Tex. When tool failure does occur in the hole, redesign is sought to avoid similar failures. Several unusual failures encountered in oil field work were described.

A rapid growth in consumable electrode vacuum arc melting of metals was predicted by W. W. Dyrkacz, manager of quality, Allegheny Ludlum Steel Corp., Watervliet Works, before the *Boston Chapter*. This is due, the speaker indicated, because increased demand and enlarged production has resulted in substantial price reductions for a number of vacuum melted steels. A stop-motion movie gave visual evidence of the considerable degassification which occurs in the vacuum remelting of an air-melted electrode of A-286 alloy.

Editor Advocates Constant Design, Materials Changes

IF A COMPANY IS USING THE SAME materials to make the same products that it was two years ago, it's either losing money or missing opportunities for profit, stated Edward N. Case, metallurgical editor of *Steel* magazine, before the *Tulsa* Chapter.

"The product might still be good enough but a competitor taking advantage of technological developments can make it better or make it cheaper", he said.

Warning that the competitor need not be a domestic producer, Case added: "Lower labor costs overseas must be countered by better use of our technology if we are to avoid shipping jobs outside our borders. It's a continuous process since our foreign competitors are also trying to improve their manufacturing materials and processes".

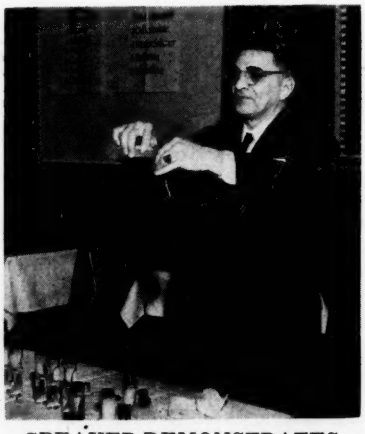
The editor said U.S. metal producers are aware of this competition and are developing new materials. "In fact, for *Steel's* annual compilation of available materials to be published soon, over 1000 changes were made by 100 producers of ferrous and nonferrous metals".

Pointing out that progress in one area frequently means advancement in others, Case declared: "Super pressures, super temperatures, super vacuums—all require specialized materials and, at the same time, are needed to produce specialized compositions. For example, the super alloys designed to resist high temperatures frequently must be processed in high vacuum".

He cited as examples of technological progress the use of graphite as a heat conductor in one direction but as an insulator in another, steels processed to develop nearly twice normal strength, and diamonds used to measure temperature.

Case reported that new processing methods are making steel without openhearths, forming parts without presses and drilling holes with a beam of electrons.

He concluded by saying: "While it's a tough job to keep track of improved materials and manufacturing methods, it's a necessity for a company wanting to stay competitive". *(Reported by Bob Kerwin.)*



SPEAKER DEMONSTRATES PRINCIPLES OF METAL CLEANING—*Points in his talk on metal cleaning before the Northeast Pennsylvania Chapter were demonstrated by G. A. Lux of Oakite Products Inc. Among guests at the meeting were 18 students and their advisors from nearby schools.*

Speaker Discusses Electron Metallography

Early attempts to use the electron microscope for the study of the microstructure of metals were only mildly successful, according to William L. Grube, General Motors Research Laboratories, speaking befor the *Louisville* Chapter. Due to the great variety of methods and techniques employed, the results obtained often varied widely and interpretation of the electron micrographs was hazardous. Since the magnification of the electron microscope was extremely high as compared to the light microscope, metallographers often found correlation of micrographs difficult. Consequently, acceptance of electron metallography in its formative years was slow.

In recent years, there has been much progress in making the electron microscope a useful metallographic tool. Much of this work has been done through the ASTM Subcommittee XI, E-4 on the Electron Microstructure of Metals.

After describing the features of the electron microscope, Mr. Grube explained the fundamental requirements for its use in metallography. These are: 1. Specimen must be prepared properly. 2. The prepared specimen must be replicated faithfully. 3. The resulting electron micrographs must be interpreted correctly.

A detailed description of the amorphous oxide film, plastic, metal and carbon replica techniques was given in which the advantages and disadvantages of each method was shown.

Mr. Grube presented an interesting series of light and electron micrographs on both isothermally transformed and quenched and tempered structures of eutectoid steels. Electron micrographs of pure aluminum with its subgrain structure were also shown. This subgrain structure cannot be resolved with the light microscope.

The speaker told how diffraction studies of extraction replicas have been successful in identifying constituents, such as epsilon carbide, which form in the early stages of tempering of steels. *(Reported by C. C. Jenkins.)*

Chapters Hear Talks on Space Age Metals

THE SPECIAL MATERIALS PROBLEMS of the space age have claimed the attention of many ASM chapters this season, among them being the *Rocky Mountain* Chapter in Denver and the *Phoenix* Chapter.

Speaking before the *Rocky Mountain* Chapter, Walter Leaf, supervisor of mill processing research section, Crucible Steel Co. of America, pointed out that the high-performance alloys must meet multiple requirements. In addition to high strength at elevated temperatures, we need corrosion resistance and high strength-to-weight properties for underwater use.

Although titanium would appear to meet both requirements, it suffers too much loss of strength above 1000°F. Thus, special stainless steels and high-strength, low-alloy steels are being used in increasing proportions. Chromium alloys are gaining extended usefulness by the addition of molybdenum, tungsten and vanadium. Tantalum, tungsten and rhenium are excellent hot performers, but extremely expensive.

Improved properties are attained in many alloys through vacuum melting which lowers gas content, decreases nonmetallic inclusions and reduces hot shortness. Porosity and shrinkage troubles are also reduced.

In *Phoenix*, Wolfgang Stuerer, chief of engineering materials at Convair, San Diego, stressed the urgent need for better materials to cope with the requirements of space technology. Many of the problems revolve about heat absorption in various high-temperature skin designs for aircraft, missiles and rockets.

New materials are being developed for space vehicles including satellite re-entry, ballistic missile re-entry, booster glide, rocket aircraft and jet fighter planes and bombers. However, every time a new barrier is broken more problems present themselves to the metallurgist.

Dr. Steurer stressed the need for all workers on space projects to use every means available to eliminate errors and produce a 100% reliable product. "An error of a microinch at the launching pad means hundreds of miles of error when the missile or rocket gets into outer space", he cautioned.

Materials Costs Defer Auto Jet, Thomson Tells Philadelphia

A LARGE GROUP OF HIGH-SCHOOL students, guests of the *Philadelphia* Chapter, heard R. F. Thomson, head, Metallurgical Engineering Dept., Research Lab., General Motors Corp., offer insight into the fascinating field of new material development in his presentation of "Metals and Materials for Automobiles of the Future". Noting that while the automobile, with its materials of construction, is not as glamorous as a space vehicle, its position in the American economy attaches real importance to efforts for improving performance while reducing costs.

Important considerations in developing and selecting a new material for auto construction are: (1) engineering properties, (2) appearance and (3) cost. Generally speaking, it is difficult to develop new materials which satisfy the first two requirements and are still competitive in cost. There has been considerable research, development and speculation on the use of a gas-turbine power plant. However, the gas turbine's future will depend upon the development of heat resistant, high hot strength materials with lower cost. The impact of the small foreign cars and the American compacts emphasizes the desirability of moving in the direction of lower vehicle weight and improved fuel economy.

Consideration must be given to improved reciprocating engines where the present low cost of raw materials, essentially cast iron and steel, limit changes for economic reasons. Nevertheless, in Dr. Thomson's opinion, we are moving into an exciting period of automotive metallurgical history where a variety of new materials and fabricating techniques will be competing in a highly competitive market for the large automotive tonnage. *(Reported by C. A. Turner for the Philadelphia Chapter.)*

CHAPTER MEETING CALENDAR

Albuquerque	**Jan. 19**	Hotts Dinner Bell Restaurant	**J. A. Burgard**	Application of Metallurgical Principles to Product and Design
Birmingham	**Jan. 10**		**J. C. Hamaker**	Toolsteels and High-Strength Steels
Buffalo	**Jan. 12**		**William Baldwin**	Residual Stresses in Metal
Calumet	**Jan. 10**	Phil Smidt Restaurant	**F. E. Van Voris**	Columbium and Other Alloy Developments in Steelmaking
Cedar Rapids	**Jan. 9**	Roosevelt Hotel	**E. E. Bishop**	Spark Testing
Chicago	**Jan. 9**	Dohl's Morton House	**K. G. Hookanson**	Hot Extrusions of Steel Shapes
Chicago-Western	**Jan. 16**	Old Spinning Wheel	**G. A. Roberts**	New Developments in Toolsteels
Cleveland	**Jan. 9**		**Panel**	Heat Treatment of Structural Alloys
Columbus	**Jan. 4**	Christian Church	**D. H. W. Allen**	Metallurgical Quality Control
Dayton	**Jan. 18**	Engineers Club		Rare Earth Metals and Their Uses
Fort Wayne	**Jan. 9**		**Paul A. Lauletta**	Properties of Lead-Bearing Austenitic Stainless Steel
Milwaukee	**Jan.**			Winter Party
Mohawk Valley	**Jan. 9**		**Merrill Scheil**	National Officers' Night
Muncie	**Jan. 10**		**Harry H. Kessler**	Cupola Operation
New Hampshire	**Jan. 13**		**Charles T. Morgan**	Ultrasonics in Inspection and Quality Control
New Jersey	**Jan. 16**	Essex House	**John P. Nielson**	Metallurgy in the Commercial States
New York	**Jan. 9**	Brass Rail Restaurant	**Warren Savage**	Liquation Hypothesis Metal Failures (Why Weld Metal Fails)
North Texas	**Jan. 12**		**Irwin Such**	Foreign Competition and the Effects on Our Market
Northeast Pennsylvania	**Jan. 12**		**John A. Fellows**	Properties of Hadfields Manganese Steel
Notre Dame	**Jan. 11**		**W. R. Hibbard**	High-Temperature Alloys
Oak Ridge	**Jan. 18**	Holiday Inn	**F. G. Tatnall**	Philosophy of Measurement
Ontario	**Jan. 6**	Fischers Hotel	**M. J. Lavigne**	Atomic Reactor Metals
Oregon	**Jan. 13**	Congress Hotel	**Exchange Speaker**	
Peoria	**Jan. 9**		**O. E. Cullen and J. E. Tripp**	Recent Developments in Production Heat Treating
Philadelphia	**Jan. 27**	Engineers Club	**Clarence R. Smith**	Fatigue and Aeronautical Structures
Phoenix	**Jan. 17**		**J. C. Hamaker**	Recent Advances in Toolsteels
Pittsburgh	**Jan. 12**	Gateway Plaza	**Carl E. Swartz**	National Officers' Night
Purdue	**Jan. 17**	Purdue Memorial Union	**Harold De Groff**	Research in Space (Flight Problems)
Rocky Mountain	**Jan. 20**	Oxford Hotel	**C. Arthur Zeldin**	Progress in the Art of Continuous Casting
Saginaw Valley	**Jan. 10**	High Life Inn	**W. S. Pellini**	Materials for Space Flight
St. Louis	**Jan. 5**	Clayton Elks Club	**Herbert True**	
San Fernando Valley	**Jan. 24**	Glen Aire Country Club	**Weston Morrill**	Modern Magnetic Materials
Southeast Ohio	**Jan. 5**	Berwick Hotel	**A. L. Ascik**	Recent Trends in Melting Stainless Steel
Syracuse	**Jan. 3**	Onondaga Hotel		Ladies Night
Toledo	**Jan. 12**	Maumee River Yacht Club	**K. L. Fetters**	New Developments in Steelmaking
Tri City	**Jan. 10**		**W. G. Johnson**	Dislocation Properties and Plastic Deformation
Upper Ohio Valley	**Jan. 11**		**Carl Schwartz**	Continuous Casting
Washington	**Jan. 9**	Amer. Assoc. Univ. Women's Club	**Fred D. Rosi**	Materials for Auxiliary Power Energy Conversion
Wichita	**Jan. 17**		**C. A. Mueller**	Heat Treating in Controlled Atmosphere
Wilmington	**Jan. 11**	Fabian's Restaurant	**R. W. Fountain**	Refractory Metals and High-Temperature Alloys
York	**Jan. 17**		**Carl Zapffe**	Science, Religion and World Events

ASM NATIONAL AND REGIONAL TECHNICAL MEETINGS

New Mexico Regional Conference, Albuquerque, N.M., Feb. 16 & 17, 1961
"Recent Developments in Materials for Nuclear Applications"
Western Metal Congress, Los Angeles, Calif., March 20-24, 1961
Indiana Symposium, Purdue University, W. Lafayette, Ind., Apr. 15, 1961
"Vacuum Metallurgy"
Chicago-Western Seminar, Chicago, Ill., Apr. 20, 1961
"Properties of Metallic Surfaces"
Southern Metals Conference, Atlanta, Ga., Apr. 24-26, 1961
National Metal Congress, Detroit, Mich., Oct. 23-27, 1961

Art of Metallurgy Still Leads the Science, Chalmers States at New York

"METALLURGY, ONE OF THE OLDEST professions, has grown rapidly in the past 20 years, but the science is still chasing after the art", according to Bruce Chalmers, Gordon McKay Professor of Metallurgy at Harvard University and 1960 recipient of ASM's Albert Sauveur Achievement Award, in a statement made in his talk "Physical Metallurgy—a Science or an Art" at Students' Night of the *New York* Chapter ASM.

"If we had our present theories 200 years ago, we, as metallurgists, would have been able to predict many of the common metallurgical phenomena, such as age hardening", Dr. Chalmers stated. However, even our present theories are not sufficient to predict the properties of our more complex alloys.

The electronics industry has had a remarkable growth due to the developments gained scientifically, with many of the predications coming from metallurgical theories; for example, zone refining.

Dr. Chalmers stated that the schools of today should teach the science rather than technology in the light of the following points:

1. Students who understand the nature of metals are thereby better equipped to render a service to a plant than those who attend schools which teach current technology, as technology is so varied that no one person can know it all.
2. A study of "trouble shooting" of a process may evolve a new process based on the principles of metallurgy upon which a given process depends. In situations of this type, the scientifically trained personnel will have a better chance of being able to carry forward the necsary development work.
3. Develop a proper understanding for future developments of materials by reasoning and deliberating which process is possible, establishing absolute limits such as strength at high and low temperatures and what stresses are to be encountered. Theory will give absolute limitations of a metal and a student using theory should be able to evaluate the claims of proposed new process.
4. Trial and error must give way to predications based on science. Science is now close to the point where it will start to surpass the empirical in the field of metallurgy.

The training of a Ph.D. in metallurgy presents a problem in that research should be stressed, developing a metallurgist capable of discussing with others the facts unearthed, searching of the literature, thinking for oneself and using the facts uncovered in a scientific manner. Metallurgy can be introduced at the graduate level after a study of the basic sciences or in an undergraduate program. But, if all metallurgists are taught either method, we tend to develop personnel in a single pattern. Therefore, some students must take metallurgy at the undergraduate level to maintain a balanced approach in the field of metals.

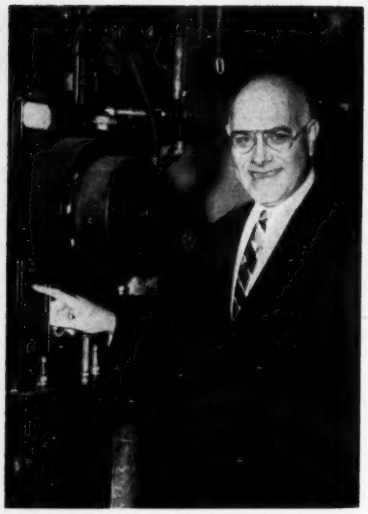
Students should first tackle simple problems by methods other than trial and error. Include in the student's basic knowledge the study of a metal such as lead, followed by a study of single crystals, heat flow, solidification, structure and segregation, applying this knowledge to technological significance.

Dr. Chalmers further stated that a student should then tackle problems such as the physical systems, including work hardening and cold rolling, so that one may predict the properties of cold rolling a metal. To attack a problem, first apply "trial and error" to establish which direction to proceed. Then apply intuition, limited only by the wide variety of existing information at the mind's disposal.

Materials other than metals should be included in a course in material science, such as semiconductors, ceramics, possibly organic material such as polymers and wood. Also include a study of crystalline material science, such as semiconchloride and noncrystalline vitreous material. *(Reported by Oliver E. Olsen for New York.)*

YOUNG CHAPTER STUDIES METALLURGY—*Ronald A. Nadler, mill metallurgist at Titanium Metals Corp., Toronto, Ohio, instructs a class of one woman and 36 men in "Elements of Metallurgy" an MEI course offered by the Upper Ohio Valley Chapter. The class meets at the College of Steubenville. A second class of 16 students meets in the Research Building, Benwood Works, Wheeling Steel Corp., Wheeling, W. Va., with M. L. Lazear, chief research engineer of Wheeling Steel, as instructor. The Upper Ohio Valley Chapter, less than one year old, chose the MEI course for its first educational effort.*

Starting the Presses for the New Metals Handbook



ON THE WAY . . . *Taylor Lyman, editor of the ASM Metals Handbook, pushes the button that starts ten railroad cars of paper through the giant presses for the new 8th Edition of the Metals Handbook, "Properties and Selection of Metals". Called the most authoritative source book on properties and selection of metals ever assembled, the new 1200-plus page book is expected to be in members' hands shortly after the first of the year.*

Baltimore Hears Talk on Treating Missile Cases

MISSILE METALLURGY depends upon the skill of the heat treater, according to Horace Knerr, president, Metlab, Philadelphia. In speaking before the *Baltimore* Chapter, Mr. Knerr stated that designers have found that oil-hardening steels develop optimum strength-weight ratios at lowest cost.

However, he continued, the tolerances demanded in these thin heat-treated shells tax the abilities of heat treaters. At times, specifications are impossible and could be avoided by consultation with metallurgists before specifications are fixed. Where oil-hardening steels cannot provide required tolerances, it might be necessary to use 5% chromium air-hardening steels.

Mr. Knerr emphasized the use of the inverted pit furnace for hardening of missile bodies. Hanging the part vertically prevents the distortion normally experienced in a conventional box or car bottom furnace at austenitizing temperatures.

Likewise, the rapid transfer to the hot oil bath below the inverted pit minimizes any thermal gradients that can cause distortion. As a result, distortion can be controlled to acceptable tolerance limits normally developed only in an austempered part. In addition, the mechanical properties of a tempered martensitic structure developed by the method were found to be better than those of a bainitic structure. The freedom from contamination by the hard-to-remove salts eliminates the possibility of chlorides accelerating corrosion or the nitrites developing an explosive reaction with the rocket fuels. *(Reported by C. E. Wirsing.)*

Translate ASM-SLA Classification

The ASM-SLA Metallurgical Literature Classification, International (2nd) Edition, published by the American Society for Metals in 1958, has been translated into Italian, according to announcement by the Istituto Siderurgico Finsider.

The text of the Classification was published in the April 1960 issue of *La Metallurgia Italiana,* and a book containing this Italian version, complete with indexes in both Italian and English and description of the system, will be published by the Associazione Italiana di Metallurgia late in 1960 or in early 1961.

The Classification was also translated recently into German by the staff of the Verein Deutscher Eisenhuttenleute. Plans for distribution and use of this German version have not yet been completed.

The Italian edition, according to the Istituto Siderurgico Finsider, contains some additional items which did not appear in the American International Edition of 1958. These were selected, after careful consideration by the committee in charge of the Italian translation, as being useful additions to bring the concepts in the classification up to date and in line with European practice.

In this connection the American Society for Metals would welcome suggestions from users of the scheme in this country who have had occasion to expand it in various ways. It is hoped that arrangements can be made for official approval of such additions to maintain the international unity of the scheme.

Users of the system are requested to direct their suggestions for revisions and expansions to Mrs. Marjorie R. Hyslop, American Society for Metals, Metals Park, Novelty, Ohio.

JOMINY RECEIVES MARTENS MEDALS — *Walter E. Jominy, retiring secretary of ASM, was presented the Adolph Martens Memorial Medal at the Oct. 3, 1960, regular Detroit Chapter meeting. The medal presentation was made by Hans Diergarten (right) representing the board of directors of the German society equivalent of ASM. This silver medal has been presented to only two others in its 17 years of existence and Mr. Jominy is the only American so honored. He is also a Past National President ASM; recipient of the Sauveur Achievement Award ASM; recipient of a University of Michigan, Distinguished Alumnus Award; listed in Who's Who in America and Who's Who in Engineering.*

After accepting the Martens award and plaque Mr. Jominy received a standing ovation from the 300 members present. Mr. Jominy is best known to metallurgists for his work with the world-wide recognized end quench hardenability test for constructional alloy steels.

EMPLOYMENT SERVICE BUREAU

Operated on a no-charge basis for A.S.M. members in good standing. Ads are limited to 50 words and only one insertion of any one ad. Address answers to: Box No., American Society for Metals, Metals Park, Novelty, Ohio, unless otherwise stated.

POSITIONS OPEN

East

FELLOWSHIPS AND RESEARCH ASSISTANTSHIPS: In metallurgy at eastern university. Research stipends starting at approximately $3,600 per year for B.S. degree holders with no experience. Arrangements permit full-time experimental and course work toward M.S. or Ph.D. degree. Available July or Sept. 1961. Box 12-15.

METALLURGIST: Excellent opportunity for man with B.S. or M.S. degree, with minimum of five years' experience, to establish and operate metallographic laboratory in large metropolitan New Jersey research laboratory engaged in semiconductor and thermoelectric work. Must possess good laboratory technique as well as a sound theoretical background. Salary commensurate with experience. Send résumé to Box 12-20.

PHYSICAL METALLURGIST: Large metropolitan New Jersey research laboratory currently engaged in semiconductor and thermoelectric field seeks senior man with broad and proven background in physical metallurgy. Minimum of five years' experience; Ph.D. desirable but not essential. Salary open. Send complete résumé to Box 12-25.

SALES ENGINEER: For Buffalo territory. Well-established company with national sales representation requires a man for Buffalo territory. Excellent opportunity for one with background preferably in metallurgy or mechanical engineering. Reply to P.O. Box 2395, Buffalo 23, N.Y.

METALLURGIST: Commercial heat treating shop desires graduate with 5-10 years experience in stainless steel heat treating and brazing, using atmospheres and vacuum. Set up and operate laboratory facilities for research, development and quality control. New York location; salary open. Box 12-30.

Midwest

FELLOWSHIPS AND ASSISTANTSHIPS: for advanced degree students in the fields of metallurgy, ceramics and semiconductors. A new materials research center provides exceptional facilities for basic research and graduate studies in kinetics, physical ceramics and metallurgy, imperfection studies in solids, physics of solids, thermodynamics and X-ray diffraction. Applicants with degrees in mathematics, the physical sciences or engineering will be considered. Dept. of Metallurgy and Materials Science, The Technological Institute, Evanston, Ill.

RESEARCH METALLURGISTS: Excellent openings in established Detroit laboratory engaged in ferrous and refractory metals research. Applicants should be college graduates in metallurgy. Research experience an advantage but not a requisite. Please furnish full details of education and experience along with expected salary and recent photograph. Apply direct to Climax Molybdenum Co. of Michigan, 14410 Woodrow Wilson, Detroit 38, Mich.

SOME FORMAL TRAINING in the physical sciences, willingness to continue education in related areas, and interest in atmosphere brazing and heat treating may qualify you for a salaried position in a newly formed process engineering section of a growing organization located in Cleveland. Two plants, approximately 150 employees. Box 12-95.

Canada

CHAIR OF METALLURGY: McMaster University invites applications for appointment to the Steel Co. of Canada chair of metallurgy. Considerable research experience is required and interest in the physical chemistry of iron and steelmaking is highly desirable. The successful applicant will also hold a senior academic appointment, associate professor or professor, and will be expected to do some teaching at the undegraduate as well as at the graduate level. Salary open. The metallurgical laboratories occupy about 18,000 sq. ft. of floor space in the one-year-old engineering building. About one-half of this laboratory space is devoted to research. Equipment available for research uses include a 30-lb. vacuum melting and casting furnace, X-ray diffraction and fluorescent analysis equipment, physical testing machines, a liquid helium cryostat, a one-megawatt nuclear reactor and a Bendix G-15 electronic computer, as well as almost all of the usual appurtenances associated with scientific and engineering research in metallurgy. For further information write: Chairman, Dept. of Metallurgy and Metallurgical Engineering, McMaster University, Hamilton, Ont., Canada.

Southwest

FORGING ENGINEER—Excellent opportunity with oil well manufacturer in Houston for experienced forging engineer, 36 years old or younger. Engineering degree required. Moving expenses paid by company. Contact W. F. Cannon, Personnel Manager, Reed Roller Bit Co., P. O. Box 2119, Houston 1, Tex.

SALES POSITION

The Allvac Metals Company, producer of induction vacuum melted high temperature alloys, alnico and ceramic permanent magnets has sales positions open.

QUALIFICATIONS: B. S. degree in engineering. To 30 years of age. Free to travel. Willing to contribute to and share in the growth of youngest specialty metals company in the U.S.

CONTACT: William O. Nisbet, V. President, Box 611, Monroe, N. C.

PHYSICAL METALLURGIST

Permanent position immediately available in our modern, well-equipped metallurgical research laboratories. Applicants should possess an advanced degree in metallurgy, or a BS in metallurgy plus minimum 3 years' experience, preferably in copper and copperbase alloys.

Professional challenge in the area of alloy development and fundamental studies of the structures, constitution and properties of copper-base alloys.

Send resume in confidence to:

R. H. ENDRISS

OLIN MATHIESON CHEMICAL CORP.

125 Munson St.

New Haven, Conn.

MATERIALS SCIENTIST

Advanced degree in engineering with five or more years experience in the metalworking industries, principally in process research and development. Knowledge of dynamics, stress analysis, and metallurgy of metal working required. Will be responsible for the analysis and development of metal forming processes and research in die design.

Interested applicants should forward complete resume to Mr. R. W. Speich, Salaried Personnel, Box 17—

AERONUTRONIC DIVISION

FORD MOTOR COMPANY

DEFENSE PRODUCTS GROUP

FORD ROAD, NEWPORT BEACH, CALIFORNIA

METALLURGIST AND POWDER MET

Three challenging positions in the powder metallurgy field with one of the largest iron powder producers.

SERVICE ENGINEERING

5 to 10 years experience in applied powder metallurgy and parts manufacturing. Applicant must be willing to travel about 30% of the time.

DEVELOPMENT, PRODUCTION

Position of major responsibilities, pilot plant development, thorough theoretical and practical knowledge of metallurgy necessary.

RESEARCH AND DEVELOPMENT

Laboratory position for recent graduate metallurgist. Interested metallurgists should send their resume, marked to the attention of the president. All information will be treated strictly confidential.

HOEGANAES SPONGE IRON CORP.

Riverton, N. J.

Excellent Career Opportunities for RESEARCH METALLURGISTS in Solar's Expanding Research Laboratories

IN SUNNY SAN DIEGO

Expansion of Solar's Advanced Research Group and Applied Research Laboratory have created several excellent opportunities for experienced metallurgists.

EXPERIENCE SOUGHT

Research Metallurgists with graduate training or research experience for senior positions in a group engaged in basic studies in such fields as ultra-high strength materials, new methods of joining metals, and high speed deformation of metals.

Research Engineers, Physical Chemists and Metallurgists with experience in light weight, high strength materials as applied to high speed aircraft, missile and space flight problems.

SOLAR SPECIFICS

Solar is a medium-size company (2000 people in San Diego) founded in 1927. It is big enough to offer the most advanced personnel policies, yet small enough for rapid individual advancement and recognition. Salary and performance reviewed semi-annually. Solar is making many significant contributions to power plant design and advanced materials technology—both metallic and nonmetallic. There is an excellent balance between military and commercial contracts. Professional status of scientists and engineers is fully appreciated and recognized. Research laboratories are located in a brand new specially designed building completed in 1960.

WONDERFUL LIVING

Solar is located in San Diego—a city which offers the nation's finest year-around sunny climate and unmatched cultural and recreational advantages. And San Diego is rapidly becoming one of the leading research centers of the nation. There are four universities in San Diego, including the new advanced science branch of University of California, where you can continue your studies if you wish. All in all—San Diego living is great!

WRITE TODAY

If you would like to undertake exciting new research projects, while rapidly advancing your career, send a resume of your qualifications to Louis Klein, Dept. E-708, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company

Career opportunities for metallurgists

Can you qualify for the opportunities that INCO's Research Laboratory offers to metallurgists who are able to plan and conduct research in these fields?

- **Corrosion research** on both ferrous and nonferrous metals and alloys and coated metals, and the fundamental mechanisms involved in corrosion.
- **High temperature research** in developing alloys for service at all temperatures and studying the basic factors that control resistance to deformation.
- **Cryogenic studies** of effects of deep sub-zero temperatures on mechanical properties and behavior of metals.
- **Research on the effects of alloying elements** on ferrous and nonferrous casting alloys to develop new alloys and improve methods of melting and casting.
- **Welding research** to develop new welding rods and techniques for existing and newly-developed alloys.

Requirements: **Ph.D. or Sc.D. Also M.S. degree with research experience is acceptable.**

More information is given in the current report of INCO Laboratory activities, "Metals Plus Research." Do you want to review a copy?

Director of Research
The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

POSITIONS OPEN FOR INQUIRING MINDS IN MANUFACTURING RESEARCH ENGINEERING!

Bendix of Kansas City, Missouri needs three Manufacturing Research Engineers to do original work with new materials, and close, more exacting work with ordinary materials —Minds that will inquire into the many branches of technology and bring together that combination of techniques capable of producing a unique product. As a Prime Contractor for the Atomic Energy Commission, our function is to give the Weapon Designer the greatest possible latitude in exploiting new materials and techniques. We do this by paralleling his design work with advanced development of manufacturing processes during the design phase. The control of processes must frequently be so precise that automation is required for that reason alone —production quantity notwithstanding.

Engineers who can fill these positions must combine original thought with solid training in the basic physical sciences. They must be able to combine the reasoning of several disciplines in the development of a solution. Minimum requirements include:

- Engineering Bachelor's Degree in Mechanics, Metallurgy or Chemistry.
- Strength in one or more of the following fields: subminiature transformer and toroid production, metal finishes, and fabrication and assembly of precise and delicate electrical and electronic assemblies requiring special environmental facilities.

These are responsible positions for engineers who are qualified to do original and creative work, and who can demonstrate by a record of past professional accomplishment that they possess this ability. Ours is one of the nation's most vital industries. We offer unusually generous company benefits in a community which is famous for its beauty and low cost-of-living. All replies will be strictly confidential.

For Personal Interview send resume to Mr. T. H. Tillman

Box 303-QW, THE BENDIX CORPORATION
95th & Troost, Kansas City 41, Missouri

PLANT METALLURGIST

BS-MS Metallurgy or Metallurgical Engineering for Materials Engineering Laboratory staff position with chemical complex producing over 600 different products. Prefer man with 3-5 years industrial experience and a knowledge of metallography, properties of materials, and who is familiar with metal fabrication techniques and design. Work involves conducting laboratory and field investigation of metal failures and other metallurgical problems, and advising others on the proper materials and design for specific applications.

Excellent opportunities for advancement as technical expert or supervisor with the leader in the chemical industry. Located in Midland, Michigan, a community of 27,000 with ideal family living, cultural and recreational advantages.
Send resumé to:

Technical Placement Department
Box 468
The Dow Chemical Company
Midland, Michigan

INSTANTLY MEASURES COMPRESSION OR TENSILE LOADS

P55

- Accurate to within 1% of full scale capacity.
- Jewelled dial indicator repeats perfectly.
- Shockless mechanism for rough jobs.
- Red maximum pointer registers peak loads.
- Optional switch controls mechanisms.
- Accommodates wide variety of attachments.
- Available as combination push-pull model.
- Extremely compact. Fits into "tight" spaces.
- Flexes millions of cycles without damage.

12 different capacities from as low as 0-10 lbs. up to as high as 0-50,000 lbs.

WRITE FOR FREE ILLUSTRATED CATALOG AND PRICE LIST

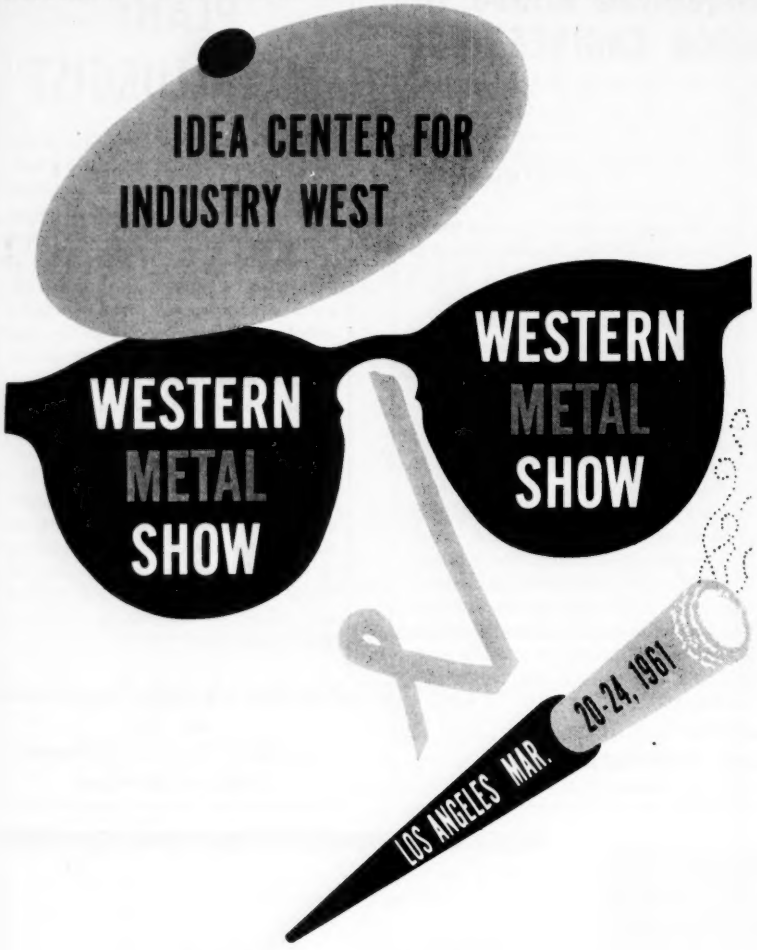
W.C. Dillon & CO., INC. 14628 Keswick St. Van Nuys 26, Calif.

Employment

● The continual expansion of our central Research Laboratories offers a rich opportunity for qualified professional metallurgists, MS or Ph.D. The highly diversified product line of this established, progressive corporation provides opportunity for company-sponsored metallurgical research of almost unlimited variety and scope. Personal interest, initiative, and achievement are recognized in a work environment designed to maximize individual freedom and opportunity. Write giving details of educational background and prior work experience to:

J. T. Jarman
Assistant to Vice President
In Charge of Research
Allis-Chalmers Manufacturing Co.
P.O. Box 512
Milwaukee 1, Wisconsin

PROCESSING • DESIGN • HEAT TREATING • RESEARCH • TESTING • MELTING



Ideas to improve production . . . to cut costs . . . to beat competition . . . you'll get ideas aplenty at the American Society for Metals' stimulating, educating Western Metal Congress and Exposition.

New equipment, exciting displays, thought-provoking processes and products . . . plus a program of technical sessions to give practical ideas for immediate use. This year, the 12th Western Metal Show is certain to be more rewarding to visitors than ever. This show is one of the major factors that has made the West our ever-expanding industrial center.

Don't miss it. Plan now to invest as much time as possible there . . . and be the Idea-Man for your organization.

WESTERN METAL CONGRESS & EXPOSITION
Pan-Pacific Auditorium, Los Angeles, California

AMERICAN SOCIETY FOR METALS
Metals Park • Novelty, Ohio • Phone ED 8-5151

Show Hours: Mon. Noon-10 P.M.; Tues. Noon-10 P.M.; Wed. Noon-10 P.M.; Thurs. 10 A.M.-6 P.M.; Fri. 10 A.M.-6 P.M.

POSITIONS WANTED

TECHNICAL MANAGEMENT: Metallurgical engineer with six successful years of research and development project engineering and technical liaison desires advancement into commercial marketing and sales functions. Box 12-35.

RESEARCH ASSISTANT: Opportunity for graduate study and fundamental research at major eastern university leading to M.S. or Ph.D. in materials science. Prefer B.S. in physical metallurgy, physical chemistry or physics. Full-time research during summers. Available immediately. Box 12-40.

INVESTMENT CASTING SUPERINTENDENT: Age 35, with 10 years experience in all phases of investment casting, process development and high-volume production. Experienced in high-temperature alloy preparation, ceramic shell process, gating design, tooling and short lead time prototype castings. Other experience includes heat treating, forging and rolling of airfoil shapes. Box 12-45.

PHYSICAL METALLURGIST: Dr. Chem. Eng., age 29, married with no children. Four years experience, partially in the U.S., in metallographic and metallurgical laboratory for research and development of nuclear alloys. Several publications. Not U.S. citizen, good English, planning a trip to U.S. for possible interviews January 1961. Desires a permanent position either in the U.S. or abroad. Box 12-50.

ELECTROCHEMICAL ENGINEER: B. Met. E., graduate work. Ten years laboratory experience in metal finishing field, four years in supervisory capacity. Extensive background in tin, cadmium, nickel, zinc and chromium plating solutions, conversion coatings for metals and corrosion testing. Desires responsible position in research and development or manufacturing. Will relocate. Box 12-55.

METALLURGICAL ENGINEER: B.S., age 29, single, veteran. Experience in ferrous and nonferrous metallography, testing, heat treating, quality control and production problems. Desires production or development position with opportunity for advancement. Box 12-60.

METALLURGICAL ENGINEER: M.S. degree, age 43. Two years experience in materials engineering, 7 years technical military, 12 years teaching, some research and consulting. Interested in mechanical behavior of metals and ferrous physical metallurgy. Desires responsible position in development or materials engineering. Prefers West Coast. Box 12-65.

METALLURGIST: B.S. in metallurgy, graduate study, age 29, single. Over seven years experience in development and specification of metallic materials and processes; failure analysis; trouble shooting; ferrous and nonferrous metals. Desires position of responsibility and growth within commuting range of New York City. Box 12-70.

ACADEMIC POSITION: Senior research metallurgist, B.S. in chemical engineering, Ph.D. in metallurgy, age 39, family. Academic and industrial research experience in process and physical metallurgy. One year teaching. Languages. Desires teaching and research position in university. Box 7-75.

RESEARCH AND DEVELOPMENT MANAGER: Heavy experience in metallurgical research and development supervision plus top-notch engineering work. Knows research and development personnel; program planning; budgeting and execution. Broad experience with aluminum, reactive metals, high-temperature alloys, cast iron, steels and ceramics. Mid-30's, M.S. degree, publications. Medium or small company preferred. Box 12-80.

METALLURGICAL ENGINEER: B.S. degree, age 27, single. Four years in alloy development on nuclear fuel materials, including use of rare earth metals and considerable study of casting and fabrication techniques. Would consider traveling job or position in development laboratory. Box 12-85.

LIBRARIAN OR REFERENCE LIBRARIAN: Varied metals and engineering experience. Has organized and set up three new libraries. Particularly interested in reports and special materials. Member: ADL, ASLIB, SLA, ASM, ISI. Prefers West or Southwest. Box 12-90.

ATOMIC PERSONNEL, INC.
WRITE FOR APPLICATION OR SEND RESUME
•
CONFIDENTIAL HANDLING
A NATIONAL EMPLOYMENT AGENCY for the NUCLEAR FIELD
•
NO CHARGE TO INDIVIDUALS
Suite 1207-J, 1518 Walnut St., Phila. 2, Pa.

METALLURGIST
$9000-15,000
Co. Pays Agency Fee

Excellent medium size New England mfr requires engineer with minimum 2 years supervisory experience. ALUMINUM ROLLING essential—Growth company, opportunity leading to executive assignment.

Write Mr. G. C. Dean

ENGINEERING
EMPLOYMENT SERVICE INC.
217 Broadway N.Y. 7, N.Y.

METALLURGISTS—With 0 to 4 years experience for challenging research and development programs involving beryllium metal. Projects include basic property studies, metal forming and fabrication. Excellent opportunities in a rapidly growing industry. Send resumes in confidence to:

Mr. R. M. Quimby, Personnel Director
The Beryllium Corporation
P.O. Box 1462
Reading, Pennsylvania

RESEARCH & DEVELOPMENT METALLURGISTS

YOUNGSTOWN Sheet and Tube Company has se eral excellent career opportunities for qual fied men in its new program of expansion in Research and Development.

B. S. or advanced degrees are required for positions involving both technical and supervisory responsibilities. Openings in areas of process, physical and product metallurgy. Also in coating and corrosion and raw materials field.

Salaries based on experience and education.

Send complete resume to:

R. A. Nittinger, Asst. Manager
Organization Planning
Youngstown Sheet and Tube Company
Youngstown 1, Ohio

METALLURGIST

with production experience in wire drawing, preferably stainless steel. Position: Head of department. Our employees know of this opening. Box 12-5

SUPERVISOR

for Wire Drawing Department. Supervisory and metallurgical experience essential. Our employees know of this opening.

Box 12-10 Metals Review Metals Park, NOVELTY, OHIO

ALLOY RESEARCH

Metallurgical degree. 2-10 years experience. Opening in Research & Development with prominent steel company on tool, alloy, magnetic, high-temperature, and stainless steels. To $12,000.

tomsett
associates inc.
Management Personnel Counselors
431 Frick Bldg. Gr. 1-2050
Pittsburgh 19, Pa.

An Important New Career in Metallurigical Engineering

has been opened up by ASM's electronic Information Searching Service.

Needed are graduate metallurgical engineers, preferably with some practical experience, who can guide the interpretation of a wide range of metallurgical subject matter. Library training or knowledge of computer techniques is not essential.

Here is a career opportunity to get a foothold in a new and growing field of metallurgical science and technology which is of vital importance to the nation's economy.

Send record of qualifications and experience to:

American Society for Metals
Att: Mrs. Marjorie R. Hyslop
Metals Park
Novelty, Ohio

Go West in March

for Sunshine and Ideas!

12th Western Metal Congress and Exposition

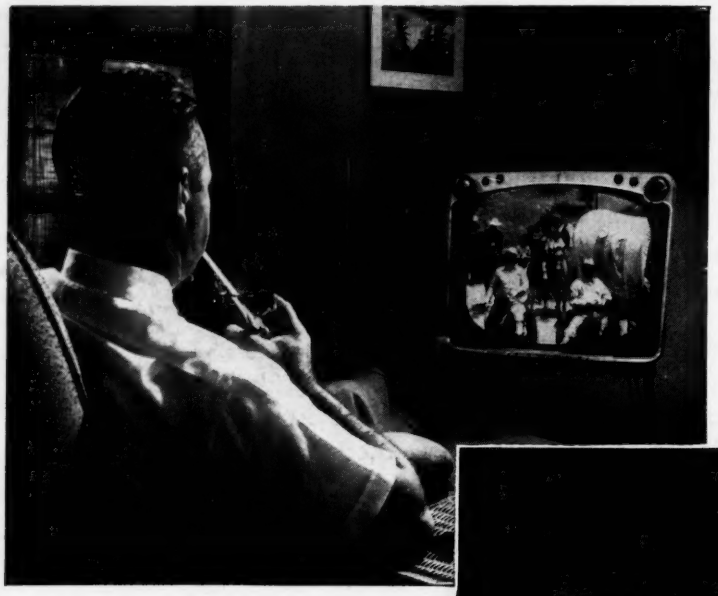
Pan-Pacific Auditorium (Exposition)
Ambassador Hotel (Congress)
Los Angeles, Calif.
Mar. 20-24, 1961

Plan to see scores of idea-full exhibits in the big Western Metal Show . . . to hear the top-flight engineering experts at technical sessions presented by ASM, SNT, AWS, AIME, SAMPE and ASTM—a full week of materials technology.

Write now to Hotel Ambassador for your room reservation and take an active part in the discussions and exhibits that await you at "IDEA CENTER FOR INDUSTRY WEST".

AMERICAN SOCIETY FOR METALS

Metals Park Novelty, Ohio



WHICH MAN IS MORE LIKELY TO SUCCEED?

How you spend your spare time can affect your future.

What MEI students say:

"The course was very beneficial and I feel because of it, I was offered a better position."

"Thanks to your course, I have taken over the job of my previous supervisor."

When opportunity for promotion presents itself, it may then be too late to *begin* studying. The man who *has already studied* and who is *now* capable of undertaking the job, will often get the nod and forge ahead.

Do you ever ask yourself "Do I know enough?" or "Would I be better off in the long run if I learned more?"

Metals Engineering Institute, the education division of the American Society for Metals, offers twenty home study courses on a variety of metallurgical subjects from Elements of Metallurgy to Metals for Nuclear Power. They can be helpful to you as they have been to thousands of others; send for the free catalog and enrollment information by mailing in the coupon below. This can mean the difference between "Me and He" when opportunity knocks.

METALS ENGINEERING INSTITUTE, Dept. R-120
Metals Park, Novelty, Ohio

Please send catalog, covering twenty courses in detail, and enrollment information, at no obligation to me.

Name_____

Address_____

_____

Metals Engineering Institute
A DIVISION OF
AMERICAN SOCIETY FOR METALS